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RECORDS

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VIII. MATERIALS FOR A SURVEY OF THE MOSQUITOES OF CALCUTTA.

By C. A. PAIVA, *Assistant, Indian Museum.*

[NOTE.—The delay in the appearance of this paper is due to the fact that owing to the absence during almost the whole time of the survey as well as for many years previously, of any scientific officer who could devote more than a small part of his time to the supervision of the conservation of our extensive entomological collections, Mr. Paiva has been unable to devote more than a fraction of his time to mosquito work. For the same reason the survey cannot be regarded as exhaustive, or even sufficient for the "fringe area" to which it was confined, since the methods employed were rough and ready in the extreme. Their chief defects lie in the lack of adequate supervision over the collectors, and in the identification by means of the adults only of the larvae and pupae obtained. With regard to the first of these defects, Mr. Paiva tells me that it was easy to keep a check on the truth of the collectors' statements as to the nature of the breeding-places from which different collections of larvae were brought in, as he quickly found that some species preferred one sort and others preferred others, a fact which could not be taken into account by an ignorant collector anxious to avoid any suspicion that he neglected filthy water. But he was quite unable either to see that every type of breeding-place found was regularly sampled or to instruct the collectors personally in the art of finding larvae in large areas of water over which they might be dispersed; and it is probably on this account that no species known to transmit malaria has been revealed in the collections made either by the corporation kerosening-coolies or by the collectors subsequently employed by the Museum; for it is well known that these mosquitoes breed in clean water. With regard to the second defect mentioned above, it may be pointed out that just as different species of wild animals differ in their ability to thrive in captivity so some species of mosquito develop in captivity more readily than others, and although identifications ought to be checked by rearing up the larvae, they ought always, in the first instance, to be based on the larvae and pupae themselves; for otherwise there is a danger that some species may be completely overlooked owing to their inability to develop under the conditions to which they are subjected. To have done this, however, it would have been necessary for Mr. Paiva to devote the whole of his time to the work at the actual time when the survey was in progress, and this it was impossible for him to do; in addition to which, at the

commencement of the survey, the Museum did not possess a collection of properly named mosquito larvae on which he could have based his identifications. Such a collection has now been formed, both of the common species obtained during the survey, and of some of those found in Calcutta tanks; and I should like to take this opportunity of thanking Major Christophers, I.M.S., and Capt. Davys, I.M.S., for the assistance they have given me by sending isolated larval and pupal skins, together with the adults which emerged from them, of several species not common in Calcutta. But the absence of Mr. Paiva on medical certificate, an absence which will certainly be of long duration and from which it is very doubtful whether it will ever be safe for him to return, has rendered it impossible for the Museum to undertake, as had been hoped might be made possible, a second and more thorough survey on the lines indicated above. And it is in the hope that the experience and unavoidably imperfect results of what has already been done may be of use to others that the present paper has been compiled.—F. H. GRAVELY, Asst. Supdt., Indian Museum.]

Early in October 1909, the Calcutta Corporation commenced the destruction of mosquito larvae in that part of the town locally known as the "Fringe Area," and as it was important to know what species abounded in that area, living specimens of larvae were daily sent to the Indian Museum from every spot which was visited, together with the precise locality and breeding ground of these larvae.

Larvae were received with considerable regularity but for two interruptions which were occasioned by the Durga Puja and Christmas vacations. The larvae were successfully reared in the Museum, and the mosquitoes that emerged from each batch were carefully pinned and labelled. After a large number had been collected, I identified them to the best of my ability.

The Calcutta Corporation stopped the supply of mosquito larvae on the 26th February 1910, without previously informing the Museum authorities that the work was not to be carried on any longer by them. As it was the intention of the authorities of the Museum to carry on the breeding of mosquito larvae for a complete year, arrangements had to be made to secure men to collect larvae during the remaining period, *i.e.*, till the first week of October 1910. It was an extremely difficult task to secure really reliable men for the work and this caused an interruption of a little more than three weeks. On the 22nd March 1910, the work of collecting larvae commenced again, and after several changes of collectors, two men were finally selected for the work. In a short time the daily supply of larvae became enormous and consequently very large numbers of mosquitoes emerged daily. These could not all be pinned, so they were killed and put into separate pill-boxes and after all the mosquitoes had been thus duly arranged, I counted and identified them and made the necessary entries in a rough register. Thus did the work continue till the beginning of October 1911.

In the early part of the survey, I did not think it necessary to separate the *Culex* with the unbanded proboscis from those with the banded proboscis, but later on I considered it advisable to keep them separate. Hence it will be seen that from March 22nd 1910, the two forms are given as *Culex* A (unbanded proboscis) and *Culex* B (banded proboscis).

The following species were bred during the twelve months of the survey:

Culex A.
Culex B.
Culex concolor, Desv.
Leucomyia gelida, Theob.
Stegomyia scutellaris, L.
Stegomyia fasciata, Fab.
Desvoidea obturbans, Wlk., and varieties.
Toxorhynchites immisericors, Wlk.
Myzomyia rossii, Giles.
Myzomyia ludlowi, Theob.

The area dealt with in the survey has been divided into ten districts which are briefly defined and described in Table I.

Table II gives full particulars of the work done during the year. Each column represents a fortnight's work; Roman figures are used to indicate the districts from which the various larvae were brought in; and the actual number of adults that emerged is shown by Arabic figures in brackets.

In the next three Tables (III, IV and V) the breeding habits for the three principal seasons are compared: *viz.* the "hot," "rainy" and "cold" seasons.

The hot season in Calcutta generally commences early in March and extends at least to the end of May or the beginning of June. There are occasional showers of rain during this period, but mosquitoes do not find much stagnant water about to encourage the breeding of larvae. Some species however are rather common at this time of the year.

The rainy season commences in June or July and ends after the 15th of October. At this time water is most plentiful and hence it is the most suitable period for the breeding of mosquito larvae.

The cold season starts in November and lasts till the end of February at latest. There is very little or no rain during this time and mosquitoes do not seem to be so plentiful.

It is generally during the cold season that the Calcutta Corporation undertakes the destruction of mosquito larvae. A more suitable time of the year for this kind of work would perhaps be the rainy season as during that time larvae are found in abundance in all kinds of situations, and mosquitoes are most common then. The constant rain may render it difficult to do this work satisfactorily however.

The most common situation in which larvae were found during the rainy season was in earthen pots, except in the case of one species (*Myzomyia rossii*) which was found chiefly in open drains, but during the other two seasons, tanks, open drains, cisterns, cesspools and earthen pots were all utilized as breeding places with about equal frequency. Other artificial collections of water, such as that in tubs, metal cans, iron and earthen pans also served as breeding places, but did not seem to be patronized very much by mosquitoes; probably because some of these were less common, whilst others, being shallow, quickly dried up. In one instance, a canal served as a breeding place for *Myzomyia rossii*.

Table VI shows the number of specimens of each species that emerged during each of the three different seasons and their relative percentage. It will be seen that *Culex* A was the most abundant mosquito in all the seasons. *Myzomyia rossii* was commoner during the hot and rainy seasons than during the cold weather. The largest number of mosquitoes emerged during the rainy season, being as much as 69·9% of the year's total, clearly indicating that the larvae were more easy to obtain at this time than at any other.

The larvae of *Culex* A were found mostly in open drains during all the seasons.

Larvae of *Culex* B were found in about equal proportion in tanks, open drains and earthen pots during the rainy season, and in open drains during the hot season.

Culex A (with the proboscis unbanded) belongs rightly to the *fatigans* group of that genus, and I have noticed all varieties, both in respect to size and markings, emerge from a batch of larvae collected at one time from a single piece of water.

The forms of *Culex* with the banded proboscis (*Culex* B) belong to the *impellens* group.

These were the only two forms of the smaller species of *Culex* which emerged from larvae received during the year's survey.

Larvae of *Culex concolor*, Desv., were not very plentiful and were chiefly found during the rainy season in small collections of water, *viz.*, cesspools, tubs, iron pans and earthen pots, in company with larvae of *Culex* and *Stegomyia*. These larvae are of carnivorous habits and small collections of water are most suitable for them as they can easily capture any other larvae which may breed along with them in these situations.

Larvae of *Leucomyia gelida*, Theob., were only common during the rains, and were obtained chiefly from earthen pots, although some were got from tanks and open drains. This species appears to be entirely absent in the "Fringe Area" during the other two seasons.

Larvae of *Stegomyia scutellaris*, L., were procured in very large numbers during the three seasons from earthen pots, but chiefly during the rains.

During the other two seasons larvae were obtained from open drains and metal cans as well.

Larvae of *Stegomyia fasciata*, Fab., like *S. scutellaris*. were obtained mostly from earthen pots. These two species generally choose small collections of stagnant water to breed in. They will never be found to breed in any foul-smelling water, at least this is what I have observed. They do not seem to like muddy water either.

S. scutellaris and *S. fasciata* are the two principal mosquitoes which are such a source of annoyance in Calcutta during the day. They are purely day feeders and I have never yet caught one in a room after it has become dark.

Larvae of *Desvoidea obturbans*, Wlk., were found in cesspools and earthen pots during all the seasons, and during the cold season were very plentiful in open drains, which apparently contained foul stagnant water The larvae of this species find cesspools very suitable for breeding. They seem to thrive in foul water.

Larvae of *Toxorhynchites immisericors* Wlk., breed chiefly in earthen pots and were found in fairly large numbers in such situations during the rainy season. During the other two seasons very few were obtained.

Larvae of *Myzomyia rossii*, Giles, found open drains most suitable during the rainy season, but during the other two seasons they were very numerous in tanks as well.

Larvae of *Myzomyia ludlowi*, Theob., were most common during the rainy and cold seasons, scarcely any having been got during the hot season. Their principal breeding grounds were open drains and earthen pots.

The last two species closely resemble one another. The only constant difference between *M. ludlowi* and *M. rossii* is that in the former the legs are speckled, and it is doubtful, as Theobald suggests in vol. v of his "Monograph of the Culicidae of the World," whether it is really more than a variety. Theobald still retains *ludlowi* in the genus *Myzomyia*, but Maj. S. P. James, I.M.S., now regards it the type of a new genus.

Table VII indicates the difference between the proportion in which the various kinds of breeding places are utilized in different localities. This may perhaps be due in some degree to selection on the part of the collectors; but I do not think that it can be entirely accounted for in this way, in which case a difference in the relative abundance of the various kinds of breeding places in the different districts is indicated.

Earthen pots in most cases proved to be the most usual breeding places. In some cases open drains were found to be equally suitable.

Earthen pots were quite common in districts i, ii, iii, vi, viii, ix and x. Larvae of every species found during the survey were taken from earthen pots, especially during the rainy season.

District vi gave the largest number of mosquito larvae, then came districts i, ii, viii, ix, x, iii, vii, iv and v according to the number of larvae found in each district.

From the foregoing remarks it will be seen that not a single specimen of the larvae of any species known to carry malaria has been found in the fringe area, where malaria is most common as far as Calcutta is concerned. Adults of some of these species are to be found in houses in the fringe area when carefully searched for but they must either breed beyond the limits of the area, or in comparatively large areas of water where the collectors did not make proper investigations

TABLE I.[1]

I. Bounded by Circular Canal, Maniktala Road and Upper Circular Road. Includes many oil mills, rope factories, flour mills and bustees; tanks very numerous, some of them clean and others dirty.

II. Bounded by Maniktala Road, Circular Canal, Beliaghata Road, and Upper Circular Road. Includes Sealdah station with its extensive railway yards, a large gas works, a large flour mill, an ice factory, and bustees. There is one tank which is covered with weeds.

III. Bounded by Beliaghata Road, Circular Canal, Beliaghata Canal, Convent Road, Middle Road Entally, and Lower Circular Road. Includes Beliaghata railway station, railway workshops, pumping station, Campbell Hospital with a big clean tank in its grounds, a big dirty tank covered with green slime and water lilies, and ground for entraining rubbish; the rest is composed of bustees with the exception of a small European quarter in the south.

IV. Bounded by Beliaghata Canal, Kankurgachi Chord (E.B.S. Ry.), the line to Diamond Harbour, and Convent Road. Includes a small canal of very dirty smelling water running close behind a slaughter-house, and the Roman Catholic Orphanage with open grounds and a clean tank; all the rest is covered with bustees and small tanks.

V. Bounded by Beliaghata Canal, the Municipal Boundary, New Tengra Road, and Tengra Road. Includes continuation of dirty canal found in District IV, with some brackish water tanks to the north of it, many hide godowns, tanneries, etc., and some bustees.

VI. Bounded by Middle Road Entally, the line to Diamond Harbour, Tiljalla First Lane, Karaia Road, and Lower Circular Road. Includes European quarter, cemetery, etc., on the west; all the rest of the district is occupied by bustees with numerous tanks covered with green slime, and a few tanneries in the south-east.

VII. Bounded by Kankurgachi Chord (E.B.S. Ry.), Tengra Road, New Tengra Road, and Municipal boundary (Topsi Road and Tiljalla Road). Includes Mohammedan cemeteries and bustees with tanks covered with green slime on the west, and more open country on the east.

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[1] This table has been compiled, since Mr. Paiva left Calcutta, with the assistance of Mr. Hodgart, who made the necessary investigations; previously it had been thought that a map would perhaps have been sufficient. F. H. G.

TABLE I—*continued.*

VIII. Bounded by Beck Bagan Bazaar Lane, Tiljalla First Lane, Molvi Ahmad Khan Bahadur's Road, E.B.S. Railway, Garcha Road, Hazra Road, Ballygunge Circular Road. Includes European quarters and a few bustees; many tanks both clean and dirty.

IX. Bounded by Lower Circular Road, Ballygunge Circular Road, Hazra Road and Russa Road. Includes Port Trust Offices with small depôts for coolies, large European quarter, and a few bustees; many tanks, both clean and dirty.

X. Bounded by Lower Circular Road, Russa Road, Hazra Road, Tolly's Nulla, and Bhawanipur Road. Includes General Hospital, Lunatic Asylum, European quarter, and bustees; there are a few tanks, these including a large municipal tank which is clean and free from weeds.

25-i to 7-ii-10.	8-ii to 21-ii-10.	22-ii to 26-ii-10.	27-ii to 21-iii-10.
VI, VII, Tank (10). II, VI, Open drain (15). II, Cesspit (2). I, II, Earthen pot (17). I, VI, ? (8).	I, VII, Tank (6). I, II, III, Open drain (40). I, V, VI, ? (17).	VI, Tank (6). I, II, Open drain (19). VI, ? (8).	No collecting done during this period.
Nil.	Nil.	Nil.	
Nil.	Nil.	Nil.	
Nil.	Nil	Nil.	
Nil.	Nil.	Nil.	
IV, ? (3).	VII, Tank (3).	Nil.	
Nil.	Nil.	Nil.	
VIII, Tank (6). VIII, Open drain (5).	VIII, Tank (2). I, II, VIII, Open drain (13).	Nil.	
I, Earthen pot (2 near drain).	I, Open drain (1).	Nil.	

i to 29-xi-09.	30-xi to 13-xii-09.	14-xii to 27-xii-09.	28-xii-09 to 10-i-10.	11-i to 24-i-1
VI, VIII, Open 95). rthen pot (30). VI, ? (34).	II, Tank (14). II, III, IV, VI, Open drain (169) IV, VI, ? (28).	III, Tank (9). II, IV, VI, VII, Open drain (110). Metal can (17). II, Earthen pot (22).	II, IV, VI, Open drain (47). I, Metal can (11). I, Earthen pot (1). V, ? (20).	VI, Tank (6). II, III, IV, VI drain (45). I, Earthen pot (8) IV, ? (2).
Nil.	Nil.	Nil.	Nil.	Nil.
en pot (1).	Nil.	Nil.	Nil.	Nil.
Nil.	Nil.	Nil.	Nil.	Nil.
drain (3).	Nil.	Nil.	Nil.	I, Earthen pot (2)
drain (7). u pot (1).	VI, Tank (2) VI, Open drain (23). II, Earthen pot (5). IV, VI, ? (9).	Nil.	Nil.	III, ? (3).
en pot (31).	I, Open drain (11). VI, Cesspit (38). I, Earthen pot (4). IV, ? (1).	II, Earthen pot (29).	Nil.	Nil.
14). II, Open drain u pot (1).	VI, Tank (2).	III, VI, Tank (4). II, Drain (2).	I, Metal can (1).	VI, Tank (4). III, Open drain (1 I, Earthen pot (1)
drain (3).	Nil.	Nil.	Nil.	II, Open drain (1

Date.	5-x to 18-x-09.	19-x to 1-xi-09.	2-xi to 15-xi-09.
Culex A .. / Culex B ..	VI, Tank (12). VI, Open drain (2). VI, Cistern (10). I, Cesspit (1). VI, Tub (4). I, II, VI, Earthen pot (57). I, II, VI, Earthen pot near tank (4). II, ? (8).	I, Earthen pot (88 near tank).	III, Tank (23). I, II, IV, VI, Open drai. (137). VI, Cistern (2). I, II, Earthen pot (21). VI, ? (38).
Culex concolor ..	Nil.	Nil.	VI, Open drain (1).
Toxorhynchites immisericors.	II, Earthen pot (1).	Nil.	Nil.
Leucomyia gelida ..	Nil.	I, Earthen pot (2).	II, VI, Open drain (6). VI, ? (1).
Stegomyia scutellaris ..	VI, Tub (1). II, Earthen pot (29).	Nil.	IV, Open drain (1). I, Metal can (3). I, Earthen pot (7).
Stegomyia fasciata ..	VI, Open drain (1). VI, Tub (7). I, II, Earthen pot (47). II, ? (68).	Nil.	VI, Tank (16). IV, Open drain (3). VI, Cistern (4). I, Metal can (28). I, II, X, Earthen pot (138). VI, ? (2).
Desvoidea obturbans ..	VI, Tank (77). VI, Open drain (56). I, Cesspit (10). VI, Tub (11). I, II, Earthen pot (53).	I, Earthen pot (3).	VI, Tank (1). II, III, VI, Open drain (123). I, Metal can (1). I, II, Earthen pot (7). VI, ? (19).
Myzomyia rossii ..	VI, Open drain (6).	Nil.	VI, Tank (36). II, Earthen pot (22).
Myzomyia ludlowi ..	Nil.	Nil.	Nil.

Hot Weather

TABLE III.

March to May.

	Tank.	Open drain.	Cistern.	Cesspool.	Tub.	Metal can.	Iron pan.	Earthen pot.	Hollow in a piece of wood.	Canal	Earthen pan.	Total.
Culex A (*fatigans* group) ..	15·7%	69·2%	1·6%	2·7%	3·8%	0·5%	..	6·2%	..	..	..	99·7
Culex B (*impellens* group)..	3·7%	77·7%	..	..	..	..	..	18·5%	..	..		99·9
Culex concolor ..	..	..	..	..	..	..	..	..	..	..	..	..
Stegomyia scutellaris ..	..	41·6%	..	..	..	..	..	58·3%	..	..	..	99·9
Stegomyia fasciata ..	..	8·3%	30·1%	..	9 %	3·1%	..	49·3%	..	..	..	99·8
Desvoidea obturbans ..	..	19·1%	..	57·3%	..	..	..	23·5%	..	..	..	99·9
Toxorhynchites immisericors	..	..	..	..	..	..	..	..	..		..	..
Myzomyia rossii ..	51·1%	41 %	..	0·4%	..	0·4%	..	6·4%	..	0·3%	..	99·6
Myzomyia ludlowi ..	..	..	..	..	..	..	..	..	..	..	..	..

Rains

TABLE IV.

June to October.

	Tank.	Open drain	Cistern.	Cesspool.	Tub.	Metal can.	Iron pan.	Earthen pot.	Hollow in a piece of wood.	Canal.	Earthen pan.	Total.
Culex A (*fatigans* group) ..	2·5%	40·7%	2·5%	10·6%	2·7%	3·2%	7·2%	30 %	..	..	..	99·4
Culex B (*impellens* group) .	24·4%	26·1%	..	6·7%	5·4%	..	4 %	33·2%	..	..	..	99·8
Culex concolor		8·8%	..	13·2%	25 %	..	23·5%	29·4%	..	..	..	99·9
Leucomyia gelida ..	27·3%	16·4%	1·3%	..	..	..	..	54·7%	..	..	..	99·7
Stegomyia scutellaris ..	..	0·3%	1·4%	..	5·6%	3·4%	4·9%	83·3%	..	..	0·7%	99·6
Stegomyia fasciata ..	4·3%	4·8%	7·5%	..	16·8%	5·4%	2·7%	57·2%	..	..	0·9%	99·6
Desvoidea obturbans ..	3·1%	14·8%	1·6%	32%	0·4%	1 %	4·1%	42·8%	..	..	..	99·8
Toxorhynchites immisericors	..	1·7%	..	1·7%	15·5%	..	..	81 %	..	..	..	99·9
Myzomyia rossii ..	15·4%	59·5%	0·4%	0·7%	0·2%	1·6%	8·4%	13·3%	..	..	..	99·5
Myzomyia ludlowi ..	0·2%	47·1%	9·9%	..	3·9%	1·1%	..	37·6%	..	..	..	99·8

Cold Weather — TABLE V. — November to February.

	Tank.	Open Drain.	Cistern.	Cess-pool.	Tub.	Metal can.	Iron pan.	Earthen pot.	Hollow in a piece of wood.	Canal.	Earthen pan.	Total
Culex A and B ..	7·4%	79·1%	0·2%	0·2%	..	2·8%	..	10 %	..	..	..	99·7
Culex concolor.. ..		..	..	..	..	..	..	..	..	..	..	..
Leucomyia gelida ..	..	..	..	..	..	..	..	..	..	..	..	..
Stegomyia scutellaris .	..	25 %	..	..	..	18·7%	..	56·2%	..	..	..	99·9
Stegomyia fasciata ..	8·9%	13·9%	1·6%	..	..	11·4%	..	63·5%	..	..	..	99·3
Desvoidea obturbans ..	0·4%	54 %	..	15·3%	..	4 %	..	29·8%	..	..	..	99·5
Toxorhynchites immisericors	..	..	..	..	..	..	..	..	..	..	..	..
Myzomyia rossii ..	47·5%	34·9%	..	..	..	0·6%	..	16·7%	..	..	..	99·7
Myzomyia ludlowi ..	..	71·4%	..	..	..	..	..	28·5%	..	..	..	99·9

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TABLE VI.

	March to May.		June to October.		November to February.		Total for the year.
	Total.	Seasonal Percentage.	Total.	Seasonal Percentage.	Total.	Seasonal Percentage.	
Culex A	3,830	55·3%	8,201	47·1%	982	59·8%	13,013
Culex B	54	0·7%	475	2·7%			529
Culex concolor	..	..	68	0·3%	1	..	69
Leucomyia gelida..	..	..	73	0·4%	6	0·3%	79
Stegomyia scutellaris	36	0·5%	1,277	7·3%	16	0·9%	1,329
Stegomyia fasciata	385	5·5%	1,760	10·1%	236	14·3%	2,381
Desvoidea obturbans	89	1·2%	2,587	14·8%	248	15·1%	2,924
Toxorhynchites immisericors ..	1	..	58	0·3%	1	..	60
Myzomyia rossii	2,523	36·4%	2,527	14·7%	143	8·7%	5,193
Myzomyia ludlowi	5	..	356	2 %	7	0·4%	368
Total ..	6,923	99·6%	17,382	99·7%	1,640	99·5%	25,945
Percentage for the year	26·7%		66·9%		6·3%		99·9%

TABLE VII.

District.	Tank.	Open Drain	Cistern.	Cesspool.	Tub.	Metal can.	Iron pan.	Earthen pot.	Hollow in a piece of wood.	Canal.	Earthen pan.	Totals %
I ..	9(5·6%)	35(21·8%)	8(5%)	9(5·6%)	17(10·5%)	13(8·1%)	5(3·1%)	60(37·5%)	..	1(0·5%)	3(1·8%)	160 (99·5)
II ..	10(8·2%)	38(31·4%)	12(9·9)	4(3·3%)	4(3·3%)	1(0·8%)	6(4·9%)	44(36·3%)	..	..	2(1·6%)	121 (99·7)
III ..	14(18·4%)	25(32·9%)	..	5(6·5%)	1(1·3%)	..	3(3·9%)	28(36·8%)	..	..	..	76 (99·8)
IV ..	5(10·8%)	20(43·4%)	2(4·3%)	2(4·3%)	..	..	1(2·1%)	16(34·8%)	..	..	.	46 (99·7)
V ..	2(25%)	2(25%)	1(12·5%)	1(12·5%)		..	..	2(25%)	..	..	..	8 (100)
VI ..	25(12·7%)	51(26%)	12(6·1%)	12(6·1%)	20(10·2%)	12(6·1%)	14(7·1%)	48(24·4%)	1(0·5%)		1(0·5%)	196 (99·7)
VII ..	10(20·2%)	16(32·7%)	1(2%)	2(4%)	2(4%)	1(2%)	..	17(34·7%)	..	..	..	49 (99·6)
VIII ..	11(9·5%)	38(33%)	11(9·5%)	9(7·8%)	6(5·2%)	1(0·8%)	10(8·6%)	29(25·2%)	..	..	..	115 (99·6)
IX ..	11(11·5%)	17(17·8%)	1(1%)	3(3·1%)	12(12·6%)	6(6·3%)	11(11·5%)	34(35·7%)	..	..	..	95 (99·5)
X ..	2(2·6%)	15(19·7%)	6(7·8%)	3(3·9%)	3(3·9%)	5(6·5%)	9(11·8%)	33(43·4%)	..	..	..	76 (99·6)

IX. NOTES ON FRESHWATER SPONGES.

By N. ANNANDALE, *D.Sc., F.A.S.B., Superintendent, Indian Museum.*

XIV.—THE GENERIC POSITION OF "*Spongilla ultima.*"

In describing the species which I called *Spongilla ultima* I was struck by its resemblance in general structure to those which I assigned to the genus *Corvospongilla* (see *Faun. Brit. Ind., Freshwater Sponges*, etc., pp. 105, 122, figs. 19, 26), but as I failed to find in the parenchyma of the original specimens a single birotulate flesh-spicule, the species was inevitably assigned to *Spongilla*. During a recent visit to Tanjore in the Trichinopoly district of the Madras Presidency I obtained a sponge which agreed closely in most characters with "*Spongilla*" *ultima* but contained many such flesh-spicules. A fresh examination of the type specimen was therefore made and, after much hunting, a birotulate spicule was found, closely resembling those of *Corvospongilla lapidosa*. Moreover, specimens of *C. ultima* sent me from Travancore still more recently contain many birotulate flesh-spicules. It is evident, therefore, that these sponges are specifically identical and should be assigned to *Corvospongilla*. The birotulate spicules of this genus are often so few in number that great difficulty is experienced in finding them, and it is by no means improbable that other freshwater sponges of hard consistency and with gemmules in which the spicules are arranged horizontally may ultimately, on a critical examination of fresh material, have to be assigned to *Corvospongilla*. The Tanjore specimens of *C. ultima* were growing on the edge of a concrete basin which formed the outflow of an irrigation-channel full of very muddy water. They were almost black in colour and grew out from their support in flattened leaf-like expansions, some of which were divided horizontally into two thin layers by a chitinous membrane. The gemmule-spicules were not quite so irregular or heterogeneous as those of the original specimens, which were from Cape Comorin, but very few gemmules were found and it is probable that at the season at which the specimens were taken (October) the outer layer of spicules was not fully formed. The newly acquired Travancore specimens were taken in July and have well formed gemmules.

I take this opportunity to correct another error in my volume in the "Fauna." On pp. 54 and 121 it is stated or implied that the megascleres of the Bornean sponge *Tubella vesparium* are spiny. They are perfectly smooth and are distinguished from those of the Burmese *T. vesparioides* by their stouter form.

X. NOTES ON PEDIPALPI IN THE COLLECTION OF THE INDIAN MUSEUM.

By F. H. GRAVELY, *M.Sc., Assistant Superintendent, Indian Museum.*

III.—SOME NEW AND IMPERFECTLY KNOWN SPECIES OF HYPOCTONUS.

With the exception of *H. andersoni*, Oates, and *H. stoliczkae* n. sp., all the specimens on which the following descriptions are based have been added to our collection during the last year. Figures will be published in a subsequent paper dealing with the Oriental Pedipalpi as a whole, in which also I propose to discuss generic definitions in the light of the facts here published.

A.—Species with tibial spurs on the last pair of legs only.

H. dawnae, n. sp.

This species is abundant on the eastern slope of the Dawna hills in the Amherst District of Lower Burma from Sukli near the top of the range to Thingannyinaung at the bottom. I obtained a single specimen from Misty Hollow near the top of the western slope. It may, perhaps, be found over the whole of both slopes in the rains.[1] The presence of a distinct though faint and incomplete ridge between the eyes might seem to indicate that the species ought to be placed in the genus *Thelyphonus*. In all other respects, however, it is a typical *Hypoctonus*. The form of the tibial apophysis of the male especially is that of a *Hypoctonus* and not a *Thelyphonus*.

Description. ♂. Length of carapace 9·5-10·5 mm., maximum breadth 5·5—6 mm. Colour black above, with reddish-brown legs; beneath the body and arms are redder though darker than the legs. Carapace usually smooth in front and at the sides, more or less transversely rugose behind the median pair of eyes which eyes are separated from one another by a ridge whose width is about equal to the diameter of each eye. Behind this rugose area two coarsely granular bands extend backwards, one on either side of a median furrow of varying distinctness, each of them separated by a somewhat narrower smooth band from a distinct though not very strong granular ridge which extends forwards from the lateral eyes towards the median ones as in the genus *Thelyphonus*, disappearing about halfway between the two. The whole of the posterior part

[1] My collections were made towards the end of November only.

of the carapace is granular. Terga of abdomen finely granular. Trochanters and femora of second to fourth legs and tibiae of fourth legs granular above, the femora becoming smooth distally. Abdominal sterna finely and closely granular at the sides, finely but less coarsely granular between the muscular impressions on the fifth and sixth (fourth and fifth visible) segments. Arm and hand normally smooth and polished throughout above with only a few sparse punctures.[1] Trochanter with five strong teeth above and two below, the space between these two sets of teeth armed with more or less distinct rows of small denticles: femur and tibia rather large, the former armed with a stout spine below and the latter with a more or less distinct denticle (sometimes obsolete) below and a conspicuous conical process (sometimes double) at the base of the apophysis above; apophysis triangular in section, broad and flat above, strongly grooved along the anterior face, truncate distally, upper anterior margin slightly concave, posterior margin slightly concave proximally slightly convex distally, the former margin meeting distal margin in an even curve, the latter in a dentiform acute angle, distal margin armed in addition with one spiniform tooth. Inner margin of hand denticulate throughout and concave at base of fixed finger: fixed finger denticulate on both sides; moveable finger long and evenly curved; hand armed at base of moveable finger with two stout spines of which the anterior is remarkably large. Foot of antenniform leg evidently very liable to injury and specimens with an abnormal number of joints on one side at least are abundant, the long terminal joint being apparently the first to be regenerated since it is always present when the appendage is healed; normally the joints are moderately long, but the proportions they bear to one another are not altogether constant

♀. Size, colour, and general texture of integuments as in the male. Arm and hand much smaller than in male, tibial apophysis triangular, with a simple denticle at base, two more just below apex, and a row along anterior margin; second (i.e. first visible) abdominal sternum more than twice as broad as long, posterior margin slightly concave on either side, being moderately produced in the middle line with the convexity thus formed broadly rounded, impressions very faint, apparently four in number, one pair situated close together with another pair even fainter outside and slightly behind them tinged with a faint greyish streak; immediately behind the central pair the sternum is clouded with black; the concave portion of the posterior margin on either side of the median lobe and immediately behind the outer impressions is likewise blackened

H. browni, n. sp.

The following description is based on the examination of a single specimen found by Mr. J. Coggin Brown at Parni, Monglong,

[1] In a single specimen the arm and hand are slightly dulled by a very fine rugosity which is most marked at the base of the tibial apophysis and fixed finger.

Hsipaw State, North Shan States, Upper Burma. The species is very closely allied to the preceding and may be only a variety of it; but until the male is found this question cannot be settled.

Description.— ♂. Unknown.

♀. Length of carapace 8·5 mm., maximum breadth 5 mm. Texture of integuments as in *H. dawnae*, but with the median finely punctured areas of the fifth and sixth abdominal sterna very narrow. Legs of a much darker colour than in the preceding species, the coxae and trochanters above and the femora being almost black. Arm and hand as in the preceding species. Second (first visible) abdominal sternum a little less produced behind than in that species, the posterior margin being almost straight on each side instead of distinctly concave, otherwise the same

H. andersoni (Oates).

No specimen of this species appears to have been found since Oates originally described it from two specimens obtained by the Yunnan Expedition. The badly mutilated specimen which he described as the female cannot, I think, be mature, and the female of the species must be regarded as still unknown, the description of an immature specimen of *Hypoctonus* being worthless.

The male, as is well shown in Oates' figure (1889, pl. II, fig. 12) is one of the most distinct species hitherto described (though closely allied to *H. ellisi* described below), and it is difficult to see how Kraepelin (1897, p. 49, and 1899, p. 231) could possibly come to regard it as a variety of *H. formosus*. In reality it must be classed with Kraepelin's *H. gastrotrichus* on account of the presence of tibial spurs on the last pair of legs only.[1] As Oates

[1] *H. kraepelini*, Simon, also belongs to this group. Simon's description of this species (1901, pp. 77-8) is inadequate and his statement that it is closely related to *H. saxatilis*—more so, one is led to assume, than to any other known species—is misleading. The type specimens (one mature specimen and several young) from Bukit Goah, in the State of Jalor (Siamese Malay States) at an altitude of less than five hundred feet above sea level [I am indebted to Dr. Annandale for the correct spelling of this locality together with information as to the altitude at which he obtained the specimens], have been sent me for examination by Mr. Doncastor, the Curator of the Cambridge Museum, to the collection of which they belong; they may be redescribed as follows:-

♀. Length of carapace 11 mm., maximum breadth of carapace 6 mm. Carapace more extensively granular and rugose than in *H. ellisi* (see below) granulation of legs weaker. Colour much as in that species but slightly darker. Arm and hand resembling those of the female of *H. ellisi* in all points except that the tibia and hand are somewhat more elongated, each being about 1½ times as long as broad. The outermost tooth of the trochanter of the right arm is double in the only mature specimen I have seen, but this is no doubt an abnormality it does not occur either in the left arm or in any of the young specimens. Second, (i.e. first visible) abdominal sternum about twice as broad as long, posterior margin on each side perceptibly but very slightly more concave than in *H. ellisi*, the rounded middle portion somewhat less obtuse but scarcely produced. Impressions very obscure, apparently four in number arranged in a curve opposite the rounded middle portion of the posterior margin with which they enclose a broadly *navicula*-shaped area, the outer pair of impressions tinged with black. Tibial spurs confined to last pair of legs except in the one mature specimen in which one is also present on the second (but not third) right (but not left) leg, which is clearly an abnormality.

makes no mention of this feature and as only the female of *H. gastrotrichus* is known, it is not to be wondered at that Pocock (1900), though he refused to follow Kraepelin in regarding *H. andersoni* as a variety, did not succeed in placing it correctly.

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H. ellisi, n. sp.

Mr. C. E. Milner, of the Indian Forest Service, to whom I wrote in the hope of obtaining the unknown female of *H. sylvaticus*, sent me some time ago six specimens of *Hypoctonus* collected by Mr. Ellis in the Zigon Division (Burma) under rocks during blasting operations in connection with a road in the Yoma north-east of Zigon town. Three of these proved to be *H. sylvaticus*, whilst three (one male and two females) belong to a new species closely allied to *H. andersoni*.

Description—♂. Length of carapace 8 mm., maximum breadth 4·5 mm.; colour of body and arms dark brown above, that of legs pale brown; surface of carapace smooth at sides and transversely rugose in middle in front of lateral eyes, finely granular throughout behind, incompletely grooved in the middle line; terga of abdomen finely granular throughout; trochanters and femora of of 2–4th legs and tibiae of 4th legs finely granular above; anterior half of hand finely granular below; posterior lateral angles of 1st, whole of 2nd, 3rd and 4th, sides of 6—8th visible abdominal sterna finely and closely punctured and more or less transversely striate; rest of surface of body and appendages smooth and polished or sparsely punctured. Arm with a conspicuous denticle dorsal to the coxal process which is rather long and slender; upper margin of trochanter entirely without teeth, anterior surface with two or three vertical rows of denticles, one obsolete tooth on lower margin; femur very sparsely punctured, rather slender, its free inner edge about equal to anterior margin of trochanter, one obsolete denticle on lower side; tibia also very sparsely punctured, stem of tibial apophysis slender, lightly curved in the middle, expanded on the anterior edge of the upper side at first gradually then very abruptly into a flattened and downwardly curved blade which ends abruptly just before the narrow pointed extremity, lower edge of posterior side likewise expanded below the tip but thicker and the expansion nowhere abrupt; hind margin of dorsal expansion not produced backwards as in *H. andersoni*. Hand somewhat massive; fixed finger very broad, its inner margin strongly convex with the distal half very hairy, outer border finely denticulate; moveable finger with strongly curved and somewhat hairy basal portion, grooved along upper and lower and less strongly along outer margin, and followed by an abruptly defined distal portion which is straighter, slenderer, smoother, and sharply pointed at its extremity.

♀. Length of carapace 9·0—9·5 mm., maximum width of same 5·0 mm. Colour, granulation, etc. as in male except for absence of all granules from lower surface of hand. Coxal process of arm shorter than in the male, with denticles above it less

conspicuous; trochanter with five long marginal teeth above and two stouter ones below, anterior surface with rows of denticles as in male; femur much shorter than in male, armed with one tooth on lower surface, with or without a smaller one above; tibia and hand each about as broad as long, former larger than latter; tibia with one tooth above at base of apophysis and one below close to anterior margin; hand with two teeth below, the anterior and larger one close to anterior margin, the other immediately behind it: tibial apophysis with two teeth on posterior side near apex, very strongly toothed on anterior side; inner side of hand (including fixed finger), hardly perceptibly concave, toothed throughout except close to base and distal extremity, apposable margins of both fingers more finely denticulate except distally where they are smooth, moveable finger shorter and less strongly curved than in male, its lower margin strongly denticulate. Second (i.e. first visible) abdominal sternum twice as broad as long, posterior margin not produced, being practically straight on each side and very obtusely rounded in the middle: anterior margin raised up to form a strong transverse ridge in front of a pair of large and deep circular pits situated not far from one another on either side of the middle line.

B.—Species with tibial spurs on both third and fourth pairs of legs.

H. oatesii, Poc.

Of this species only the male has as yet been described. Mr. G. Mackrell of the Lungla (Sylhet) Tea Co. has however succeeded in obtaining both sexes for me from Shamshernager, Sylhet, at an altitude of about 100 feet.

Description.—♂. See Pocock, 1900, pp. 112—3.

♀. Length of thorax 10 mm., maximum breadth 5·5. Colour and texture of integuments as in male, except that the arms are not so strongly granular and the anterior abdominal sterna are not rugose at the sides. Trochanter as in male but with teeth of upper margin longer and sharper, the anterior margin moreover meeting the inner margin in a somewhat sharper angle. Femur much shorter than in male, armed with one small tooth above and one long one below; tibia and hand as in female of *H. ellisi.* Second (i.e. first visible) abdominal sternum scarcely half as long as broad, posterior margin not abruptly produced in middle; one pair of distinct circular impressions present.

H. sylvaticus, Oates.

Of this species only the male has as yet been described. I am indebted to Mr. C. E. Milner for specimens of both sexes which were captured for him by Mr. Ellis under rocks in the Zigon Division (Burma) in the Yoma N. E. of Zigon town during blasting operations in connection with a road.

Description.—♂. See Oates, 1889, pp. 18—9, and Pocock, 1900, pp. 115—6.

The colour of the legs of the Indian Museum specimen are uniformly pale as in *H. saxatilis*, but the specimen agrees perfectly with *H. sylvaticus* and not with *H. saxatilis* in structure.[1]

♀. Length of carapace 9·0—9·5 mm.; maximum breadth 5 mm. Colour and texture of integuments as in the male except for the absence of any sign of the extraordinary rugosity of the sides of the anterior abdominal sterna found in that sex. Trochanter of arm with five distinct teeth above and two below; femur shorter than in male, armed with several strong granules on the inner side above and one tooth below; tibia and hand as in the preceding species. Second (i.e. first visible) abdominal sternum scarcely half as long as broad, distinctly and more or less abruptly produced in the middle; one pair of distinct but very broad and shallow circular impressions present.

H. stoliczkae, n. sp.

The three specimens (♂, ♀, and juv.) from which this species is described are all from Punkarbari, and are apparently those from that locality referred to by Stoliczka (1873, pp. 127 and 134—136) under the name *Thelyphonus* (conf.) *angustus*. Oates (1880, p. 6) states that these are referable to the young of *Uroproctus assamensis*, a species which they resemble in the presence of a tooth on the inner side of each coxal process of the arm. Of the ridge between the median and lateral eyes there is however no trace. As the species is obviously related to forms belonging to the Burmese genus *Hypoctonus* (especially *H. wood-masoni*) and not to those of the South Indian genus *Labochirus* I have referred it to the genus *Hypoctonus* in spite of the presence of teeth on the coxal process, although this will necessitate a revision of the generic definition.

Description.—♂. Length of thorax 12 mm., maximum breadth 7 mm. Colour dark brown throughout. Carapace granular (almost spinulose) throughout, granules coarser in front than behind; trochanters and femora of 2—4th legs and tibia of 4th legs granular above; arms, except their coxae which are striate and sparsely punctured, and inner side of remaining joints strongly granular, abdominal terga also granular throughout; abdominal sterna granular at sides only, those of the first three ventrally visible segments being much more coarsely marked than the rest and almost rugose. Coxal process of arms with one or two [2] more or less distinct teeth on the inner margin near the apex and sometimes one on the outer margin also, one tooth also dorsal to base of coxal process; trochanter armed with one or two teeth below and five somewhat obscure teeth above, anterior surface with rows of denticles; femur moderately stout, its free inner margin

[1] This is not the only case in which I have found the colour of the legs to be misleading. Structure I believe to be alone reliable.

[2] The two arms of the single specimen before me differ greatly in the extent to which they are armed with spines and teeth.

quite as long as anterior margin of trochanter, with or without one strong tooth below; tibia about as wide as long, stouter than femur. one small tooth below close to anterior margin at base of moveable finger, front margin oblique, the inner side above being about $1\frac{1}{2}$ times as long as the outer; posterior side of tibial apophysis curved, slightly expanded dorso-ventrally at the end, lower anterior margin produced towards the hand to form an extensive plate widening gradually from its commencement at about $\frac{1}{3}$ of the distance from the base of the apophysis to its extremity and terminated abruptly a little before the end. Hand very thick dorso-ventrally on the outer side; inner side thin, widely excavate at base of fixed finger, the excavation exactly fitting the ventral plate-like expansion of the anterior margin of the tibial apophysis when the two are brought together; fixed finger broad, roughly parallel-sided, almost vertically truncate distally; moveable finger evenly curved, the apex crossing beneath the moveable finger when closed, and apposable to extremity of plate-like expansion of tibial apophysis.

♀. Length of cephalothorax 10 mm., maximum breadth of same 6 mm., colour much paler than in male [1] and granulation weaker throughout. Coxal process of arm as in male; trochanter with marginal teeth well developed; femur thinner and proportionally shorter than in male, armed with one weak tooth above and one very strong one below; tibia and hand scarcely longer than broad, armed as in *H. ellisi*, *H. wood-masoni*, etc. Second (first visible) abdominal sternum about twice as broad as long, middle of posterior margin somewhat abruptly produced, surface traversed by a fine groove extending slightly forwards across the middle-line from about the middle of each half of this margin, a single pair of moderately distinct circular impressions situated about half-way between this groove and the anterior margin of the segment.

IV. NEW ORIENTAL TARTARIDES.

Schizomus (s. str.) cavernicola.

Locality.—This species lives under stones in the depths of the larger of the two famous Farm or Khayon caves near Moulmein where I obtained two specimens, both adult females. I also saw, but failed to capture, some immature specimens, probably of the same species, that were living under stones in a crevice which forms the approach to an upper entrance of the small cave.

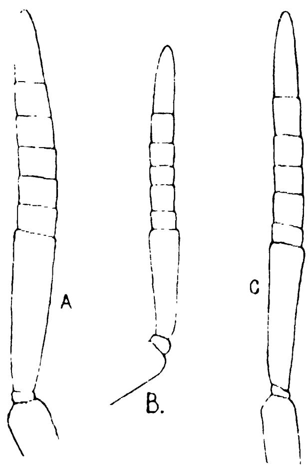
♂. Unknown.

[1] I believe that the colour of these animals is to some extent affected not only by age and by the recency of the last moult but also by the mode of preservation (e.g. the strength and nature of the spirit) employed. In the present instance, however, in view of the small size of this specimen in comparison with the male, it probably indicates that the specimen is scarcely mature; distinctive characters of the anterior abdominal sterna are already developed but they will probably be found to be intensified in perfectly matured specimens.

♀. *Cephalothorax.*—A well-defined pair of white eye-spots present: cephalic sternum about two-thirds as broad as long.

Arms.—Slightly less than half as long as the body. Anterior margin of lower part of trochanter straight or slightly concave, meeting lower margin in an angle of about 60°. The lower angle of the femur about equidistant from basal and distal ends of the upper margin of the joint or a trifle nearer to the former than to the latter. Patella a little more than twice as long as deep; claw about half as long as upper margin of tarsus.

First legs. Very long and slender, nearly half as long again as body. Coxa terminating behind base of trochanter of arm. Femur a little longer than tibia, tibia a little longer than foot (about one third as long again). Foot nine or ten times as long as



Foot of first leg of new Oriental Tartarides × 60.

A. *Schizomus* (s. str.) *cavernicola*.
B. *Schizomus* (*Trithyreus*) *greeni*.
C. *Schizomus* (*Trithyreus*) *kharagpurensis*.

deep, deepest at end of metatarsus; second metatarsus a little longer than sum of five proximal tarsal joints; terminal tarsal joint not quite as long as sum of three proximal joints and about two-fifths the length of the whole metatarsus.

Fourth legs.—About as long as body; femur two-fifths as deep as long.

Tail.—Short and stout, little more than three times as long as deep, four-jointed, the two proximal joints together about three-fifths or a half of the length of the two distal joints together.

Colour.—The general colour is grey-green, paler below than above. The membranes between the sclerites are white and very conspicuous as in *S.* (*Trithyreus*) *vittatus*, although the sclerites are not as dark as in that species. The distal part of the chelicerae but not of the other appendages is reddish brown.

Length. About 4 mm.

This species is not very closely related to any hitherto described. It resembles Simon's *a* group in the proportions of the claw of the arm and the foot of the first leg, but not in those of the tail.

Schizomus (s. str.), n. sp.

Locality.—Chaibassa, where a single immature specimen was obtained among stones on the shaded side of an old quarry. I do not think it advisable to describe this species till mature specimens are found.

Schizomus (Trithyreus) greeni, n. sp.

Localities. Mr. E. E. Green found the type specimen under a stone at Ambalangeda, S. Province, Ceylon, in company with *Amitermes quadriceps*. He has also sent me a specimen caught in the compound of the Museum, Colombo, on July 20th, 1911.

♂. Unknown.

♀. *Cepholothorax.*—Eye-spots absent; cephalic sternum rather more than three-fifths as wide as long

Arms. About half as long as body. Trochanter with lower front angle (about 120°) rounded and inconspicuous, anterior margin convex. Lower angle of femur also inconspicuous, about equidistant from basal and distal ends of upper margin. Patella rather more than twice as long as deep (about two and a half times). Claw scarcely half as long as upper margin of tarsus.

First legs.—About as long as body. Coxa terminating a little behind base of trochanter of arm. Femur somewhat longer than tibia. Foot about five-sixths as long as tibia, and about ten times as long as deep, deepest at end of metatarsus: second metatarsus scarcely as long as sum of first five joints of tarsus, terminal tarsal joint somewhat longer than three proximal tarsal joints together and quite two-thirds as long as whole metatarsus.

Fourth legs.—About as long as body; femur two-fifths as deep as long.

Tail. Broken in both specimens.

Colour. Brown.

Length. About 3 mm.

This species seems to stand nearer to S. (*T.*) *modestus* than to any other included in Hansen's table (1905, pp. 51-3.)

Schizomus (Trithyreus) kharagpurensis, n. sp.

Locality. Kharagpur in the Midnapore subdivision of Bengal where a single female was collected by Mr Hodgart.

♂. Unknown.

♀. *Cephalothorax.*—Eye-spots absent; cephalic sternum about three quarters as broad as long.

Arms.—About three-fifths of the length of the body. Anterior margin of lower part of trochanter slightly convex, meeting lower margin in an obtuse angle (about 110°). Lower margin

of femur rounded. Patella about two-fifths as deep as long. Claw not quite half as long as upper margin of tarsus.

First legs.—Long and slender, slightly longer than body. Coxa terminating behind base of trochanter of arm. Femur slightly longer than tibia, tibia longer than foot. Foot about twelve times as long as deep, deepest at end of metatarsus; second metatarsus scarcely as long as sum of five proximal tarsal joints; terminal tarsal joint slightly longer than sum of three proximal tarsal joints, and about three-fifths of the length of the whole metatarsus.

Fourth legs.—Somewhat shorter than body; femur about two and a half times as long as deep.

Tail.—About six times as long as deep, four-jointed as in *Schizomus* s. *str.*, the distal joint about one and a half times as long as the sum of the three proximal ones.

Colour.—Brown.

Length.—About 4·5 mm.

This species differs from all hitherto described in the combination of a divided second thoracic tergite with a four-jointed tail; there seem moreover to be indications of a division of the long distal joint into two parts, though of this I am not certain.

Schizomus (Trithyreus), n. sp.

Locality.—Pass between Chaibassa and Chakardharpur in Chota Nagpur. I obtained a few immature specimens under stones in the bed of a small stream in the jungle.

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XI. DESCRIPTION OF A NEW SPECIES OF FRESHWATER CRAB FROM SOUTHERN INDIA.

By J. R. HENDERSON, *M.B., F.L.S., Superintendent, Madras Government Museum.*

PARATELPHUSA (LIOTELPHUSA) MALABARICA, N. SP.

Carapace moderately flat, its length about three-fourths the greatest breadth, its depth about half the length. Under a lens the surface is seen to be minutely pitted, and there are fine oblique striae near the lateral borders; the striae are faintest posteriorly, and behind the short antero-lateral border of the carapace they curve downwards and forwards on to the under-surface of the branchial area. The anterior striae are finely crenulated.

Cervical groove limited to a well-defined crescentic depression forming the posterior boundary of the mesogastric area; on either side of this crescent, about quarter of the way back from its tip, is a somewhat ill-defined groove, which passes backwards and outwards for a short distance. The post frontal mesogastric furrow is well-defined, and faintly bifurcate posteriorly.

Front slightly more than two fifths the greatest breadth of the carapace, strongly deflexed, and with the margin almost straight. Both the front and the upper orbital margin have a clearly defined elevated edge. Outer orbital angle moderately prominent; lower orbital margin elevated, and finely crenulated.

Antero-lateral borders of the carapace short, but well defined, and faintly crenulated; lateral epibranchial tooth small and subacute.

Epigastric crests scarcely distinguishable as distinct elevations, but represented by oblique faintly eroded patches on either side of the mesogastric furrow. Post-orbital crests low, but fairly distinct, commencing at a point nearly behind the inner orbital angle.

Sixth segment of the male abdomen with its proximal and distal ends practically of equal width, but the segment slightly narrower towards the middle; the length of the segment is greater than its breadth.

Antennal flagellum very short.

Terminal joint of mandibular palp bilobed.

Exopodite of the external maxillipeds reaching the middle of the merus, and provided with a well developed flagellum. The ischium is smooth and not grooved, a very faint hollow, best seen at the proximal end, being the sole representative of the usual groove. The merus is much broader than long.

The chelipedes are unequal in the adult male, but not markedly so ; in the female the disparity is but slight. The merus and carpus, particularly the former, are squamulose on the upper surface, while the hand is practically smooth ; the spine at the inner angle of the carpus is well developed. The fingers in adult males are shorter than the palm, and somewhat unevenly toothed ; they gape slightly when closed, while their tips are horny and somewhat blunt.

The legs are a little longer than the smaller cheliped, and their joints, particularly the three terminal ones, are beset with rows and tufts of setose hairs. The dactyli are armed, above and below, with yellow setose spines, a few of which are also seen on the propodi. 10923

The colour of recent spirit specimens is bronze green above, with the undersurface and chelipedes yellowish. The distal halves of the fingers are pale brown.

Dimensions of the carapace in a male : length 13 mm. ; breadth 17 mm. ; depth 6 mm. ; width of front 6·5 mm. Dimensions of carapace in a female (the largest specimen taken) :- length 16 mm. ; breadth 21 mm. ; depth 9 mm. ; width of front 8 mm.

This species can be readily distinguished from the other species which Alcock (Catalogue of the Indian Decapod Crustacea in the collection of the Indian Museum, part I, fasciculus II, p. 109, 1910) assigns to his subgenus *Liotelphusa*. In *L. laevis* (Wood-Mason) from Assam, the carapace is more convex, the post-orbital crest is fainter, and the post-frontal groove shallower; the ischium of the external maxillipeds is longitudinally grooved, and the length of the sixth segment of the male abdomen just equals its distal breadth. From *L. austrina*, Alcock, the only species hitherto known to occur in Southern India, with which it agrees as regards the long sixth abdominal segment in the male, it can readily be differentiated. In *L. austrina*, the front is distinctly bilobed, and the post-orbital crest is very faint, while the ischium of the external maxillipeds is longitudinally grooved. In *Phricotelphusa campestris*, Alcock, from Bengal, there is a similar arrangement of the epigastric crests, but in this species the exopod of the external maxilliped has no flagellum.

Locality. I obtained nine males and eleven females, one of the latter with young in the abdominal pouch, from a stream near Kavalai, in the Cochin State Forests, last October. The locality is situated at an elevation of about 1,000 feet above sea level. They were living under stones at the side of the stream, in comparatively dry places, and few were actually observed in the water.

Paratelphusa (*Barytelphusa*) *jacquemontii*, (Rathbun) was common in the same stream, but this crab was only seen in the water.

The type (Crustacea Reg. No. $\frac{7936}{10}$) is preserved in the Indian Museum.

XII. NOTES ON DECAPODA IN THE INDIAN MUSEUM.

IV.—OBSERVATIONS ON THE PRIMITIVE ATYIDAE WITH SPECIAL REFERENCE TO THE GENUS *Xiphocaridina*.

By STANLEY KEMP, *B.A., Assistant Superintendent, Indian Museum.*

For the last few years efforts have been made to improve the collection of Atyidae in the Indian Museum and, thanks to the energy displayed by numerous correspondents, the series will, it is hoped, shortly become thoroughly representative of this important part of the Indian freshwater fauna. In course of time a full report on this family and on the Palaemonidae will be issued, forming a part of the Museum Catalogue of Indian Decapod crustacea.

The Atyid fauna of the Indian Empire comprises, so far as is at present known, only three genera, *Atya*, *Caridina* and *Xiphocaridina*. *Ortmannia* (*Atyoida*) does not seem to occur, and this, in view of Bouvier's theory of the mutational origin of that genus and of *Atya*, is a most unfortunate circumstance. It is, however, still hoped that specimens will be found which will provide material for some further consideration of this interesting question.

Atya appears to be very scarce. A few specimens from the Andamans are the only Indian representatives of the genus in the collection, while in addition there is a single example from Ceylon. *Caridina*, the prevalent genus, occurs in great abundance in every suitable locality, inhabiting both fresh and brackish water and ascending to altitudes of at least 6,000 ft. Of *Xiphocaridina* a single species only is known, obtained at Tezpur, on the north bank of the Brahmaputra R. in Assam, and in the native state of Manipur further to the east. It is with this last form that the present note is concerned.

The Atyidae as a whole must be regarded as a very primitive family of Caridea, in spite of the fact that the peculiarly modified chelae indicate a considerable degree of specialization. *Xiphocaridina* is one of the most primitive of the known genera, and it is through such forms as this and *Xiphocaris* that the common ancestry of the Atyidae and the deep-sea pelagic shrimps of the family Hoplophoridae has been traced. Bouvier (*1909a*), following Ortmann (1895), has laid great stress on this interesting feature of Caridean evolution, and his careful researches leave no room for doubt on the point.

The most conspicuously primitive feature of the genera *Xiphocaris* and *Xiphocaridina* is the possession of well-formed exopods on all the peraeopods, a schizopod-like character which they share with one other Atyid genus, *Palaemonias*, Hay, from the mammoth cave of Kentucky. In three other genera, *Syncaris*, *Troglocaris* and *Atyaëphyra*, exopods are also found on certain thoracic legs, but never on all, while they are uniformly absent from *Atya*, *Caridina* and *Ortmannia*, genera which comprise the large majority of known species of the family, and from *Limnocaridina*, *Caridella* and *Atyella* that constitute the peculiar Atyid fauna of lake Tanganyika.

Until comparatively recently the distinctions between *Xiphocaris* and *Xiphocaridina* were not recognized; but Bouvier (1909*a*) had pointed out that the West Indian *X. elongata*, the type of the former genus, differs from its supposed congeners in New Zealand, China and Australia in several important structural features. He consequently created for the latter species a new genus, *Xiphocaridina*.

Xiphocaridina is distinguished from *Xiphocaris* by the presence of supra-orbital spines on the carapace, by the anteriorly excavate carpus of the first peraeopods, by the presence of tufts of hairs on the tips of the fingers of the chelae (a character found in all Atyidae with the exception of *Xiphocaris*) and by the absence of arthrobranchs at the base of the first four peraeopods.

From a consideration of these characters it is evident that *Xiphocaridina* has proceeded on a line of specialization similar to that which has resulted in the evolution of *Caridina* and this fact determined Bouvier in his choice of its name. *Xiphocaris*, as at present understood, is the most primitive genus in the family; except for the complete suppression of the mandibular palp, it bears a very close resemblance to the Hoplophoridae.

Palaemonias, Hay (1902 p. 226), is distinguished from both the preceding genera by the distal excavation of the carpus of the second pair of peraeopods and by the unpigmented and non-facetted eyes. It appears to resemble *Xiphocaris* in the absence of a supra orbital spine and *Xiphocaridina* in the reduction of its branchial system.[1]

Up to the present time only the following species of Atyidae with the full number of exopods on the thoracic limbs have been described:

Xiphocaris elongata (Guérin).
Cuba; Hayti; Dominica; St. Domingo.

Xiphocaridina compressa (De Haan).
Yokohama; Tokio; Flores; Queensland; Victoria; New South Wales; Norfolk Is.

[1] Hay states (p. 229) that "the gills seem to be only four in number, on each side attached to the first four peraeopods, but there may be a rudiment on the fifth." In *Xiphocaridina* there are seven gills (one rudimentary) on either side and twelve (one rudimentary) in *Xiphocaris*.

Xiphocaridina curvirostris (Heller).
New Zealand; Chatham Is.

Palaemonias ganteri (Hay).
Mammoth cave, Kentucky.

It is consequently a matter of some considerable interest that one of these primitive Atyidae still persists in India, and the identification of this species with *Xiphocaridina curvirostris*, hitherto known only from New Zealand, presents a difficult problem in geographical distribution.

The material available consists of the following specimens:—

Tezpur, Darrang District, Assam. Col. H. H. Godwin-Austen. Twenty-four specimens, two of which are ovigerous females, ranging in length from 24 to 42 mm.

Manipur Hills, Manipur state. Col. H. H. Godwin-Austen. Three specimens (none ovigerous) from 24·5 to 28 mm. in length.

These examples were found many years since and it must, I think, be the case that the species is very strictly localised. On a visit to Assam a year ago I had ample opportunities of collecting freshwater crustacea at Mangaldai in the Darrang District and on the neighbouring Assam-Bhutan frontier, localities at no great distance from Tezpur. Special efforts were made to rediscover *Xiphocaridina*; but the search proved quite unavailing, although several interesting species of *Caridina* were obtained in abundance in the tributaries of the Brahmaputra.

For assistance in the identification of the specimens collected by Col. Godwin Austen I am under considerable obligation to Prof. E. L. Bouvier, who was kind enough to forward me a transcript of one of his papers on Atyid evolution that had not at that time been received in our Calcutta libraries. He also furnished me with several references which afforded valuable information and spared me from his small series in the Paris museum a specimen of *X. curvirostris* from New Zealand for comparison with the Assam examples.

Subsequently, Dr. C. Chilton, to whom I wish to convey my sincere thanks, furnished me with a considerable number of specimens, obtained in the R. Avon at Christchurch, New Zealand.

I have thus been able to make a careful comparison of Indian and New Zealand examples and no doubt whatever remains in my mind of the complete identity of the two forms. Inasmuch however, as this determination raises questions of geographical distribution of no little importance a mere statement of fact would not perhaps be acceptable and in searching for some standard of comparison between the two forms it has seemed best to adopt the somewhat laborious method of measurements, as employed by de Man (1908) in the discrimination of varieties of *Caridina nilotica*. The figures are shown in the tables on pp. 116—117 and it will be seen that, judged by this criterion, there is no room for doubt regarding the identity of the forms from the two localities. In the proportions of the antennular peduncle and antennal scale, in the

Measurements of *Xiphocaridina curvirostris* (Heller).[1]

	Tezpur, Assam.					R. Avon, New Zealand.				
Sex	♀	♀	♀	♀	♂	♀	♀	♀	♂	♂
Total length	37·5	35	33	29	3[illegible]	43	39·5	37	34·5	29
Length of rostrum ..	7·0	8·0	?	6·1	6·4	7·7	7·1	6·6	7·1	5·9
Length of carapace ..	8·3	7·8	7·1	5·8	6·0	9·2	8·2	8·0	6·8	5·5
Length of antennal scale ..	6·0	5·7	5·2	4·5	5·0	6·5	5·8	5·7	5·4	4·6
First peraeopod—										
Length of carpus ..	1·42	1·14	1·43	1·05	1·28	1·79	1·57	1·53	1·40	1·16
Breadth of carpus ..	·83	·73	·73	·53	·53	·91	·84	·78	·58	·52
Carpus: length ÷ breadth ..	**1·71**	**1·97**	**1·96**	**2·00**	**2·41**	**1·97**	**1·87**	**1·96**	**2·41**	**2·23**
Length of chela	2·12	2·06	1·90	1·65	1·58	2·48	2·23	2·12	1·84	1·31
Breadth of chela ..	·76	·74	·74	·56	·55	·87	·85	·77	·60	·56
Chela: length ÷ breadth ..	**2·80**	**2·78**	**2·57**	**2·95**	**2·87**	**2·85**	**2·62**	**2·75**	**3·07**	**2·34**
Length of dactylus ..	1·0[illegible]	·90	·91	·77	·72	1·00	·96	·84	·80	·62
Chela length ÷ carpus-length	**1·49**	**1·43**	**1·33**	**1·56**	**1·23**	**1·37**	**1·42**	**1·39**	**1·31**	**1·13**
Second peraeopod—										
Length of carpus ..	3·45	3·12	2·88	2·24	2·63	3·51	3·16	3·02	2·19	2·25
Breadth of carpus ..	·56	·51	·45	·38	·39	·56	·49	·49	·44	·35
Carpus: length ÷ breadth ..	**6·16**	**6·12**	**6·40**	**5·89**	**6·74**	**6·27**	**6·45**	**6·16**	**5·00**	**6·43**
Length of chela .. .	2·00	1·90	1·79	1·53	1·53	2·20	1·95	1·88	1·67	1·30
Breadth of chela ..	·58	·56	·53	·45	·44	·64	·59	·58	·50	·45
Chela: length ÷ breadth ..	**3·58**	**3·39**	**3·38**	**3·40**	**3·48**	**3·44**	**3·31**	**3·24**	**3·34**	**2·89**
Length of dactylus ..	1·23	1·07	1·05	·91	·91	1·18	·95	1·02	·91	·77
Carpus-length ÷ chela length	**1·72**	**1·64**	**1·61**	**1·46**	**1·72**	**1·60**	**1·62**	**1·61**	**1·31**	**1·73**
Third peraeopod—										
Length of propodus ..	3·67	3·58	3·17	2·77	3·02	4·28	3·77	3·59	3·10	2·77
Length of dactylus ..	1·03	·91	·91	·77	1·14	1·14	1·08	1·0[illegible]	1·27	·92
Propodus length ÷ dactylus length	**3·56**	**3·93**	**3·48**	**3·60**	**2·65**	**3·75**	**3·49**	**3·59**	**2·51**	**3·01**
Breadth of dactylus .	·[illegible]8	·25	·22	·18	·23	·29	·25	·25	·24	·20
No. of dactylar spines	10	10	10	8	16	11	10	11	17	12
Fifth peraeopod—										
Length of propodus ..	4·17	3·43	3·58	3·06	3·51	4·84	4·37	4·05	3·81	2·93
Length of dactylus .	1·21	1·10	1·08	·82	1·05	1·35	1·21	1·20	1·25	·93
Propodus-length ÷ dactylus-length . ..	**3·45**	**3·30**	**3·31**	**3·73**	**3·34**	**3·60**	**3·61**	**3·37**	**3·05**	**3·15**
Breadth of dactylus ..	·31	·26	·26	·24	·21	·33	·24	·30	·21	·22
No. of dactylar spines ..	66	59	63	46	65	70	65	71	70	62
Ova										
Length	..	·40	·40	..	..	..	·45	·43	..	..
Breadth	..	·25	·25	..	..	..	·20	·26	..	..

1 The measurements of total length are only approximate. Those of the rostrum, carapace and antennal scale are given to the nearest tenth of a millimetre. As regards the dimensions of the eggs the average of six measurements is entered in the case of each ovigerous female examined.

Proportional lengths of segments of peraeopods in *Xiphocaridina curvirostris.*

(FEMALES ONLY.)

	TEZPUR, ASSAM.			R. AVON, NEW ZEALAND.		
	Minimum	Average.	Maximum	Minimum.	Average.	Maximum.
First peraeopod—						
Carpus: length ÷ breadth ..	1·71	**1·9**	2·00	1·87	**1·9**	1·97
Chela: length ÷ breadth ..	2·57	**2·8**	2·95	2·62	**2·7**	2·85
Chela-length ÷ carpus-length ..	1·33	**1·5**	1·56	1·37	**1·4**	1·42
Second peraeopod						
Carpus: length ÷ breadth ..	5·80	**6·1**	6·40	6·10	**6·3**	6·45
Chela: length ÷ breadth ..	3·38	**3·4**	3·58	3·21	**3·3**	3·44
Chela-length ÷ carpus-length ..	1·40	**1·6**	1·72	1·60	**1·6**	1·62
Third peraeopod						
Propodus-length ÷ dactylus-length ..	3·48	**3·4**	3·93	3·49	**3·6**	3·75
Fifth peraeopod						
Propodus length ÷ dactylus-length .	3·30	**3·4**	3·73	3·37	**3·5**	3·61

Rostral formulae[1] of *Xiphocaridina curvirostris.*

Tezpur, Assam

$\frac{3)\,3+6+7}{5}$	$\frac{2)\,2+4+2+3}{4}$	$\frac{3)\,3+4+1+2+?}{4}$	$\frac{2)\,2+6+1+4}{4}$
$\frac{2)\,2+5+1+5}{3}$	$\frac{3)\,3+7+2+3}{5}$	$\frac{2)\,2+5+1+5}{4}$	$\frac{2)\,2+8+2+4}{6}$
$\frac{2)\,2+4+1+4}{4}$	$\frac{2)\,2+4+1+1+4}{5}$	$\frac{2)\,2+6+1+?}{4}$	$\frac{2)\,2+6+4}{4}$
$\frac{2)\,2+5+1+1+4}{4}$	$\frac{2)\,2+5+1+4}{3}$	$\frac{2)\,2+6+1}{4}$	$\frac{2)\,2+4+1+3}{4}$
$\frac{3)\,3+4+1+1+?}{4}$	$\frac{2)\,2+5+1+1+?}{5}$	$\frac{2)\,2+6+2+4}{3}$	

Manipur.

$\frac{2)\,2+4+1+1+5}{4}$	$\frac{2)\,2+4+4}{4}$	$\frac{3)\,3+5+1+1+5}{4}$

R. Avon, Christchurch, New Zealand.

$\frac{3)\,3+5+1+4}{3}$	$\frac{2)\,2+5+1+3}{5}$	$\frac{2)\,2+5+1+4}{5}$	$\frac{3)\,3+2+1+1+6}{8}$
$\frac{2)\,2+4+1+4}{4}$	$\frac{3)\,3+4+1+?}{4}$	$\frac{2)\,2+5+1+4}{5}$	$\frac{2)\,2+4+1+1+4}{6}$
$\frac{2)\,2+4+1+4}{4}$	$\frac{2)\,2+5+1+4}{5}$	$\frac{2)\,2+5+1+6}{4}$	$\frac{2)\,2+5+1+5}{4}$
$\frac{3)\,3+5+1+4}{4}$	$\frac{3)\,3+7+6}{4}$		

[1] The numbers of dorsal teeth are given above and those of the ventral below the horizontal line. In the case of the dorsal series, the full number is shown to the right of the bracket, the plus signs indicating gaps between individual teeth or series of teeth. The figure on the left, separated by the bracket, represents the number of teeth situated on the carapace behind the orbital notch. In the present species it will be noticed that these teeth invariably form a distinct series, isolated by a toothless space from those further out on the limb of the rostrum.

characters of the mouth parts, in the relative length of the peraeopods and the spinulation of their meral and carpal segments, in the branchial formula and in the armature of the telson there appears to be the closest possible resemblance between the two forms.

In point of fact, the sole difference that I have been able to discover is one of colour. In the majority of the New Zealand specimens received from Dr. Chilton the proximal part of each of the setae which fringe the antennal scale and uropods is bright purple and the same coloration is found on the terminal spinules of the telson. This curious pigmentation undoubtedly vanishes in alcohol and, although it is well shown in most of Dr. Chilton's specimens, which were collected in 1910, it could hardly be expected to have persisted in the examples from Assam which have been lying in alcohol for many years.

Xiphocaridina curvirostris was first described by Heller (1862) as a species of *Caridina* from specimens obtained at Auckland. A fuller account by the same author appeared in 1865 and in 1876. Miers included it, also under the genus *Caridina*, in his Catalogue of New Zealand Crustacea. Three years later (1879) Thomson described it as a new species of Palaemonidae, *Leander fluviatilis*; but in 1903 he realized his mistake and gave a fresh account of it [1] under the name *Xiphocaris curvirostris*. In Ortmann's revision of the Atyidae (1895) it appears as *Caridina curvirostris* with a note to the effect that it probably belongs to the genus *Xiphocaris*. Bouvier does not refer to the species in his valuable paper published in 1905; but he mentions it subsequently—using Thomson's name, *fluviatilis*—as a member of his new genus *Xiphocaridina* (1909, *a*, *b*).

The curious distribution of *Xiphocaridina curvirostris* does not, I believe, find any exact parallel among other freshwater Crustacea.

Perhaps its most peculiar feature is that the other species of the genus, *X. compressa*, which inhabits S. Australia, Flores, China, Korea and Japan appears to extend in a band completely separating the two localities in which it is known to exist. But in the present state of our knowledge it is impossible to lay any emphasis on this point, for it may well be that *X. curvirostris* still remains to be discovered in many other localities.

On turning to Ortmann's work on "The geographical distribution of freshwater Decapods and its bearing on Ancient Geography" (1902) it is at once seen from the maps illustrating the hypothetical distribution of land and sea in past geologic periods that, according to this author's views, no direct land connection between New Zealand and Assam has existed in any recent epoch. In the Lower Cretaceous, however, when a land-bridge connected S. India with Madagascar and S. Africa, and when the whole of Northern India was submerged and formed the eastern limit of the

[1] The figures given on Pl. xxix are poor.

great central sea now represented by the N. Atlantic and the Mediterranean, there existed a 'Sino-Australian' continent. This involved Eastern Asia, the Indo-Malaysian Archipelago and Australia. extending southwards to the Antarctic regions and from it a tongue of land reached out to New Zealand by way of New Guinea and Norfolk Island. During Upper Cretaceous times the 'Sino-Australian' contin nt was divided by a neck of water extending across the region now occupied by Sumatra and Celebes and the land extension from Madagascar to S. India reached north to the northern or Asiatic part of that continent. In Lower and Upper Tertiary times New Zealand was completely isolated as it remains at the present day; in the former period India was merely an island, an eastern sea-connection between the 'Mediterranean' and Indo-Pacific extending across Assam and Burma, while in the latter it approaches the shape which it at present bears.

On these theories the explanation of the discontinuous distribution of *X. curvirostris* is possible, though it can hardly be said to be very convincing. We must assume that *Xiphocaridina curvirostris* evolved from some unknown marine or freshwater ancestor in early Cretaceous or pre-Cretaceous times and remained unchanged until the present day. In the Lower Cretaceous period it would have opportunities of spreading to New Zealand on the one hand and to Lower Burma on the other. Subsequently, while becoming isolated in New Zealand it must have persisted in Burma or in the country existing to the west of it until Assam reappeared during the Upper Tertiary period.

The existence of *Xiphocaridina compressa* both in China and Japan and in Australia seems to show that this species also, according to Ortmann's theories, must have remained without sensible modification for almost as long a period. Every zoologist will readily call to mind other instances tending to a similar conclusion.

Although no exactly parallel case of geographical distribution seems to be known among freshwater Crustacea, the Megascolecid Oligochaeta of the sub-family Octochaetinae afford an instance of a closely similar nature. According to Michaelsen (1909) this sub-family is found only in India and New Zealand [1] and although no species appear to be common to the two, two genera, *Octochaetus* and *Hoplochaetella*, occur in both localities.

Michaelsen holds that the only possible interpretation of these facts is that at one period a direct land connection existed between India and New Zealand. He remarks (p. 203): "I need not explain to any zoo-geographer that the discontinuation of these two regions of distribution in the Octochaetinae is quite a common matter in geographical distribution, the two regions, New Zealand and India, perhaps together with a third region, Madagascar, the home of *Howascolex*, representing the peripheral parts

[1] Michaelsen mentions that another genus, *Howascolex*, known only from Madagascar, might perhaps also be regarded as a member of this sub-family.

of a circular distribution, the internal parts of which have been obliterated by the mighty development of younger and stronger forms, in this case the vigorous genus *Pheretima*, which, from Burma to New Hebrides in one direction and Japan in another, has suppressed and partly exterminated all other genera of earthworms, those of its own phylum or sub-family as well as those of other tribes."

It is, however, difficult to bring the case of *X. curvirostris* in line with this view. There is no evidence that *X. compressa* represents a young and vigorous type which has exterminated its near ally in localities lying between Assam and New Zealand; on the contrary it would rather seem that both species are archaic forms that must have arisen almost simultaneously and, while it is by no means impossible that *Caridina* may have suppressed *X. curvirostris* in Eastern Asia, it is difficult to see why the same cause should not have effected its destruction in Assam.

The genus *Xiphocaridina* is unquestionably a very primitive one and it may be predicted that such forms are less liable to evolve varieties, local races or other species than those exhibiting a greater degree of specialization.[1] That this is so is indeed self-evident, for a primitive form, if it be primitive, must necessarily have existed without considerable modification for a prolonged period and the mere fact that it has done this is an indication that it is less likely to adapt itself to any altered conditions of its environment than is a form which by its very specialization showed that in the past it had given a more ready response to such changes.

The full significance of the unchanged condition of *X. curvirostris* is, indeed, only realized when the great range of variation in certain other Atyidae is considered. *Caridina nilotica* is a species of wide African and Asiatic distribution. Specimens found in Bengal differ in certain measurable features from the type which occurs in Egypt and Dr. de Man has distinguished them under the name of *C. nilotica* var. *bengalensis*. Among other varieties of the same species it agrees most nearly with var. *gracilipes* found in Celebes and Salayer Is. Even within the limits of India and Ceylon, however, the form exhibits a most remarkable tendency to split into races, and series of specimens from Calcutta, Madras, Tuticorin, Ceylon and the Andamans each seem to possess its own particular characteristics.

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[1] Pocock (1889) has described several species very closely allied to *Xiphocaris elongata*; but subsequent authors have preferred to regard them merely as varieties. I am, however, of the opinion that these forms are not deserving even of varietal recognition and believe that the suggestion which Pocock himself made, that they only represent stages in the growth of a single species, is likely to prove true. The rostra of large specimens of *Xiphocaridina curvirostris* are as a rule relatively shorter than in smaller examples, and this is also the case with several species of *Caridina*. In these instances, however, the variation has not nearly so great a range as in *X. elongata*. On the other hand there appears to be some evidence that two distinct races of *X. compressa* exist on Norfolk Is. (see Thomson 1903, p. 449, and Grant and McCulloch, 1907, p. 151).

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XIII. FAUNA SYMBIOTICA INDICA.

Introductory Note.

The following papers are the first in a series that I propose to publish as occasion offers. It will deal with Indian animals of different species found living together in a manner that apparently implies something more than fortuitous concurrence. Such relations actually range in an almost unbroken chain from parasitism on the one hand through commensalism to temporary, if not accidental association on the other. In these days of extreme specialization in systematic zoology, it is perhaps just as well that, even in describing new species, attention should be called not only to their taxonomic position but also to their bionomics. Many of the species described in this series will be Polyzoa or Cirripedia, but I do not pledge myself to restrict my investigations to any particular group or groups of animals and I hope to have the help of specialists from time to time.

N. A.

No. 1.—POLYZOA ATTACHED TO INDO-PACIFIC STOMATOPODS.

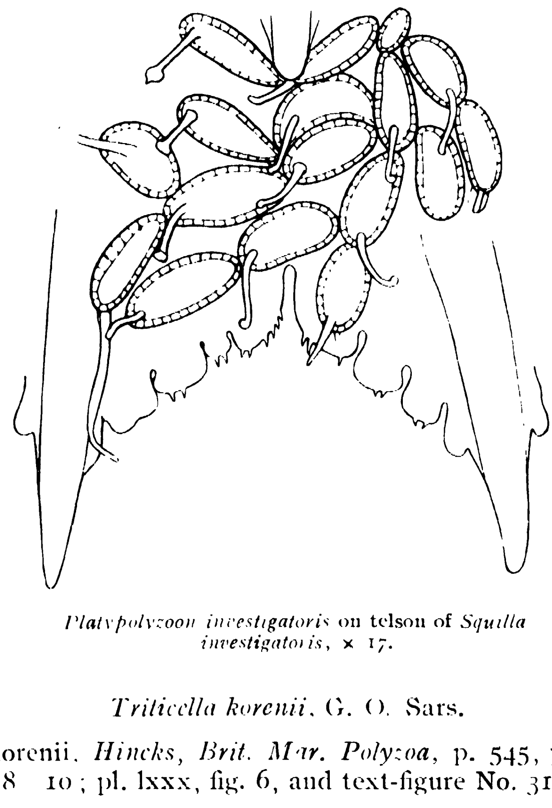
By N. Annandale, *D.Sc., F.A.S.B., Superintendent of the Indian Museum.*

A biological feature of the Stomatopoda which they share to some extent, at any rate in Indian seas, with the Decapoda Natantia and Anomoura, is the rarity with which other living organisms are attached to any part of their body. In this respect they are in strong contrast with the crabs and Reptantia, which in a large proportion of cases have small Cirripedia (usually species of *Dichelaspis* or *Poecilasma*) attached to the gills, even when the external surface is quite clean. In the collection of Stomatopoda belonging to the Indian Museum, or at present on loan in Calcutta, Mr. Kemp and I have not succeeded in finding more than half a dozen instances of sessile organisms being attached to any part of the animal.

In the case of a *Squilla*, unfortunately not identified, from the Bay of Bengal a few immature barnacles of the genus *Dichelaspis* (probably *D. warwickii*) were found attached to the pleopods, while on the dorsal surface of the carapace and abdomen of an example of *Squilla holoschista* from S. India there are several small *Balani* which I have not yet been able to identify. Mr. H. B. Preston is describing in this part of our

"Records" a peculiar mollusc taken on an Indian species of *Gonodactylus* (p. 126, *postea*).

In two instances only (one instance embracing two individuals of the Stomatopod) did we find polyzoa on the integument, and in none did we come across Hydroids or other Coelenterates. The two polyzoa are of considerable interest, one as representing a new genus and species of uncertain affinities and the other as being identical with a British species. Both species belong to the suborder Ctenostomata.



Platypolyzoon investigatoris on telson of *Squilla investigatoris*, × 17.

Triticella korenii, G. O. Sars.

T. korenii, *Hincks, Brit. Mar. Polyzoa*, p. 545, pl. xlv, figs. 8 10; pl. lxxx, fig. 6, and text-figure No. 31.

The carapace, mantidiform limbs and telson of a specimen of *Squilla fasciata* from the Bay of Tokyo, Japan, lent by Prof. K. Kishinouye, bear numerous little tufts of a polyzoon which appears to be in every way identical with the above-mentioned species. Hincks states that in European waters it is found on various crustacea, from between tide-marks to very deep water.

PLATYPOLYZOON, gen. nov.

Zoarium consisting of flattened, recumbent zooecia growing directly one from another in linear series with occasional lateral

(also recumbent) branches originating from lateral buds; sometimes more than one lateral bud on each side of a zooecium.

Zooecia membranous, hyaline, oval, very flat but with the margin supported by vertical chitinous rods; orifice situated at the summit of an elongate but slender vertical tubule which rises from near the anterior end of the dorsal surface of the zooecium. Parietal muscles consisting of short vertical strands situated round the periphery of the zooecium within the chitinous rods. Gonads arranged round the margin of the zooecium just within the parietal muscles.

Polypide elongate and slender; tentacles not numerous; no gizzard or cardiac antechamber.

Platypolyzoon investigatoris, sp. nov.

Zoarium with comparatively few lateral branches, forming a sparsely ramifying figure; no branches with subsidiary branches observed; rarely more than one lateral bud on each side of a zooecium, not more than two observed; the terminal bud of a branch sometimes drawn out into an elongate, slender process.

Zooecia oval, measuring about 1·0 mm. by 0·5 mm.; colourless except for the chitinous rods, which have a yellowish tinge. Orificial tubule of great relative length, very slender. Parietal muscles forming short, vertical, somewhat fan-shaped strands with the narrow end arising from the inner surface of the ventral wall and the broad end attached to the dorsal wall of the zooecium.

Polypide with the tentacles very long; the stomach slender and elongate; the retractor muscles delicate.

Habitat, etc.—Attached to the telson of two of the type specimens of *Squilla investigatoris*, Lloyd, from off the S. W. Coast of Arabia; 110 fathoms (R.I.M.S. "Investigator").

The affinities of the new genus and species are somewhat doubtful. The zooecia have a superficial resemblance to those of *Flustrella* and it is possible that *F. flabellaris*, Kirkpatrick,[1] from the China Sea may be related. Nothing, however, seems to be known about either the method of budding or the anatomy of Kirkpatrick's species. The structure of the orifice and the method of budding of *P. investigatoris* differ greatly from those found in *F. hispida* (Fabr.), the type-species of its genus, and possibly the former is related rather to *Arachnidium*, from which, however, it differs in that the zooecia are not separated by stolon-like processes. This is perhaps a difference of no great morphological importance, for the terminal bud in the branches of *P. investigatoris* sometimes takes the form of a slender elongate process. The form of the zooecia and the general appearance of the zoarium are strongly reminiscent of the freshwater genera *Arachnoidea* and *Hislopia*,[2] and indeed the relationship between

[1] *Ann. Mag. Nat. Hist* (6), vol v. p. 23, pl. iv, figs. 3, 3a (1890).
[2] Annandale, *Rec. Ind. Mus.*, vol. vi. p. 198 (1911).

Arachnidium and the new genus may be strictly compared with that between these two genera; but the structure of the polypide differs from that of any of the Paludicellina and the method of budding, although superficially similar, may be distinguished at once by the fact that more than one lateral bud is sometimes produced on the same side of a zooecium. On the whole, therefore, I am inclined to regard *Platypolyzoon* as allied to *Arachnidium*.

A word may be said about the function of the chitinous rods that surround the zooecium in the new species. They appear to be capable of being straightened into erect supports, but in most of the zooecia in the type specimens are bent in a >-like manner, so that the dorsal wall of the zooecium is closely approximated to the ventral. This appears to be due to the fact that the parietal muscles are strongly contracted and is possibly connected with the extrusion of the tentacles of the polypide, which in nearly all the zooecia are in a semi-extruded condition.

No. 2.—ON A NEW GENUS AND SPECIES OF MARINE PARASITIC GASTROPOD FROM THE INDIAN REGION.

By H. B. PRESTON, *F.Z.S*

Epistethe, gen. nov.

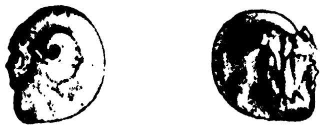
Shell imperforate, subhyaline, vitrioriform with sunken spire, the last whorl overhanging the penultimate.

Epistethe gonodactyli, sp. nov.

Shell thin, semi-transparent, sub-covneous, ovate, depressed, greyish white above, shading to brownish yellow on the last whorl; whorls 3, rapidly increasing, the first minute, the second overlapped and partly concealed by the last which is, towards the latter portion, developed above into a membranaceous infrasutural projection, and is proportionately very large, marked with radiate creases and sculptured with microscopic, silky, arcuate, transverse striae; suture impressed in the earlier, cavernous in the later stage; base of shell somewhat convex; columella callously, outwardly margined, descending in a curve; labrum thin, membranaceous, receding below, very slightly projecting in front; aperture depressedly sub-ovate. Alt. 3·5, diam. max. 6·5, diam. min. 5 mm. Aperture: alt. 3·5 (nearly), diam. 3·75 mm.

Habitat.—Parasitic on the ventral surface of a Stomatopod crustacean, *Gonodactylus chiragra*, from shallow water in the Persian Gulf; also found on specimens of the same species from the Andaman Islands.

Through the unfailing courtesy of Mr. A. C. Robson of the British Museum, who very kindly examined the animal for me,



Episcethe gonodactyli, × 2.

as far as it was possible to do so without actually abstracting it from the shell, I am able to supply the following note: "The parasite is found closely adhering to the ventral surface of its host's thorax. The means of fixation were not evident under the circumstances in which the animal was examined, though it seems likely that the foot may be modified as an adhesive organ. The only other character of interest that can be made out without dissection, is the presence of (?) epipodial fringes displayed all round the region of the foot extending two or three millimetres beyond the shell aperture as it rests applied to the body of the host. These fringes have a nodulated surface and are in many places extensively foliated. As a mere guess I am inclined to think they may be respiratory in function, but such a question can only be solved by dissection. There seems to be no reason, upon superficial anatomical grounds, for identifying it with *Cochliolepis parasiticus* (Stimson, *Proc. Bost. Soc. N. Hist.*, 1859, Vol. VI). Examination of from sixty to seventy specimens of *Gonodactylus chiragra* from the same and other eastern localities, in the collection of the British Museum, failed to reveal more examples."

I am in some doubt as to the actual systematic position of the present genus: from the shell characters alone and from the fact of its being parasitic in its habits, I would suggest the neighbourhood of *Robillardia*[1] though the foliated surface of the foot recalls certain members of the Trochidae.

[1] *Ann. Mag. Nat. Hist.*, London, 1880, vol. iii, pp. 270—71.

XIV. OBSERVATIONS ON THE INVERTEBRATE FAUNA OF THE KUMAON LAKES, WITH SPECIAL REFERENCE TO THE SPONGES AND POLYZOA.

By N. ANNANDALE, *D.Sc.*, *F.A.S.B.*, *Superintendent*, and STANLEY KEMP, *B.A.*, *Assistant Superintendent*, *Indian Museum.*

[The following notes are, in the main, the results of a visit paid to the Kumaon lakes in May, 1911, by Mr. Kemp. We have, however, incorporated also observations made by myself in October, 1907. *N. A.*]

PART I.—GENERAL.

By STANLEY KEMP and N. ANNANDALE.

The Kumaon lakes[1] are situated at altitudes of from 3,600 to 6,400 feet in the lower ranges of the Western Himalayas in the administrative district of Naini Tal. According to Theobald their origin "is due to the obstruction of local drainage caused by the debris of old moraines on the retrocession of the glaciers at the termination of the glacial epoch." None of them are of any great size, the largest, Naini Tal, covering an area of about 120 acres. The depth is as a rule considerable and in Naukuchia Tal may reach as much as 132 feet.

The principal lakes are five in number:—

	Altitude.	Maximum depth.
	Feet.	Feet.
Malwa Tal ..	3,600	127
Naukuchia Tal ..	4,000	132
Bhim Tal ..	4,450	87
Sat Tal ..	4,500	61½
Naini Tal ..	6,400	93

The banks of the lakes are steep and in most cases composed of stones, at some points with a considerable amount of fine mud.

[1] For particulars of the geology and structure of these lakes see Theobald's paper "The Kumaon Lakes," *Rec. Geol. Surv. Ind.* XIII, p. 161 (1880), and Holland's Report on the geological structure and stability of the hill slopes around Naini Tal, *Mem. Geol. Surv. Ind.*, 1897.

Although water-plants occur in the lakes, they do not form the rank masses of vegetation that often choke small ponds in the vicinity. In the middle the bottom is composed, probably in all cases, of very fine mud; but little dredging has been undertaken. In Bhim Tal and Naini Tal a certain amount of fine silt is always held in suspension in the water; this is less conspicuously the case in Sat Tal and Malwa Tal, while the water of Naukuchia Tal is remarkable for its clearness.

MALWA TAL.

This lake, which was visited only in May, is situated in a narrow gorge some 3,000 feet in depth. The most striking feature of its fauna appears to be the great luxuriance of the Phylactolaematous Polyzoa.

The most abundant form was *Fredericella indica*, a species hitherto known, in an evidently depauperated phase, from lakes in the Western Ghats and in the plains of Travancore In Malwa Tal the species formed a luxuriant growth consisting of numerous vertical branches, sometimes as much as 35 mm. long, closely pressed together and entangled. It exhibited, however, no tendency to the formation of solid bodies such as are composed by the zoaria of "*Alcyonella*." *F. indica* was found in greatest profusion at the east end of the lake, covering the under surfaces of stones in dense bushy masses; but it also occurred, though more sparingly, in other parts of the lake on the stems of water-plants. The polypides were for the most part (in May) in a state of activity and very few statoblasts could be found in the zooecia.

Plumatella diffusa was also abundant, but its polyparia were as a rule of small size. This species always forms recumbent colonies on flat horizontal or vertical surfaces but in some places the individual zooecia reach a greater length than is the case in Malwa Tal. The specimens were found most abundantly in this lake on the under surface of stones, in many cases together with *Fredericella*. *Plumatella emarginata* and *P. allmani* were both rare, the latter species being found on the stems of a rush.

One of the most interesting animals found in the lake was a new species of *Stolella*, a genus allied to *Plumatella* and recently described from the Indo-gangetic plain. The new species (*S. himalayana*) grew on the lower surface of stones together with *Fredericella* and *Plumatella*, but was very rare, only three specimens having been obtained. It formed a sparse and absolutely flat growth and seemed in danger of being overwhelmed by the more vigorous species associated with it In all three specimens there were indications that active growth had not long been in progress and numerous minute colonies, in which it was evidently just starting, were found in the vicinity of the larger zoaria. In some cases the valves of a statoblast still adhered to the pair of polypides which as yet formed the whole polyparium. The typical form of *Lophopodella carteri* was found in abundance on the

lower surface of stones and less frequently on the stems of water plants. Many of the polyparia were undergoing division and the majority contained fully formed statoblasts. This polyzoon was also found in all the other lakes of Kumaon except Naukuchia Tal and nowhere in the district was it associated with any species of alga as was the case in Igatpuri lake in the Western Ghats.[1]

The only sponge obtained in Malwa Tal was *Spongilla lacustris* subsp. *reticulata*, a form which is common in the plains of India and occurs in the W. Ghats at an altitude of over 2,000 ft. The sponge formed a small basal mass with delicate branches and was of a green colour. It occurred, in no great abundance, on the stems of plants growing in the south-eastern corner of the lake.

Of the higher crustacea only a single species (*Potamon atkinsonianum*) was obtained. As Alcock[2] has shown, *P. atkinsonianum* is closely allied to *P. koolooense*. The latter form extends from the Nepal Terai to Afghanistan, while the former ranges from the Shan States to Simla. The species are characteristic respectively of the Eastern and Western Himalayas; but the two occur together over an area reaching from Nepal to Simla and both have been taken on the shores of the Kumaon lakes.

The entire absence of Palaemonidae and Atyidae is characteristic of all the lakes and of the streams in their immediate vicinity.

When Malwa Tal was visited in May the plankton was anything but rich. Small Copepods occurred, but not in large numbers, while Cladocera and Ostracoda were extremely scarce. A few specimens of a Rotifer belonging to the family Anuraeidae were obtained and also a few Hydrachnids. A minute Peridiniid was found in small numbers. It resembles *Ceratium longicorne*, Perty, in the length of its processes, but agrees with *C. kumaonense*, Carter,[3] in having three processes instead of four: in some individuals, however, a rudiment of the fourth process can be detected, springing laterally from the anterior surface. The only adult aquatic insects which were observed were a Gerrid and a Corixid; small dragon-fly larvae were abundant and a few Ephemeridae were obtained.

NAUKUCHIA TAL.

This lake, also only visited in May, is, as is implied by its name (" the Lake of Nine Corners "), of irregular shape, not being situated in a narrow gorge.

The fauna is at once distinguished from that of Malwa Tal by the entire absence of polyzoa, so far as could be ascertained, and by the profuse growth of sponges.

The most abundant of the latter was a form of the widely distributed *Ephydatia fluviatilis*, a species not hitherto known to

[1] Annandale, *Fauna of British India*, Freshwater Sponges, etc., p. 234, pl. iii, fig. 4, and West, *Journ. As. Soc. Bengal*, 1911, p. 83.

[2] *Cat. Ind. Dec. Crustacea*, pt. I, fasc. II (Potamonidae), p. 26 (Calcutta, 1910).

[3] *Ann. Mag. Nat. Hist.* (4), VII, p. 229 (1870).

occur in India, throughout the plains of which it is apparently represented by the allied "*Spongilla*" *meyeni* of Carter. In Naukuchia Tal the species was found in two phases the peculiarities of which were probably due solely to environment. When attached to water weeds it assumed the form of solid irregular masses often of considerable size and when attached to stones round the margin of the lake grew as thin films usually more or less circular in outline.

A new variety of *Spongilla bombavensis*, a species hitherto recorded from the Western Ghats, the Mysore plateau, the Island of Bombay and S. Africa, was distinguished from all forms previously found by the production of delicate vertical branches on a basal film. It grew on branches of trees at the edge of the lake. Specimens of *Spongilla cinerea* found in the same situation showed no tendency to the formation of branches, but coated the bark in an almost uniform layer about 1 cm. thick. This sponge has hitherto only been found in the island of Bombay and in the Western Ghats.

The only large crustacean which was obtained was a specimen of *Potamon atkinsonianum*.

The plankton resembled that of Malwa Tal, but Entomostraca seemed less abundant, while Peridiniaceae were more plentiful. In addition to *Ceratium longicorne*, which here appeared not infrequently in its typical development, a few specimens of *Peridinium apiculatum*, Ehrenburg, were observed Insects again were exceedingly scarce, but a Rhynchoton belonging to the Naucorid genus *Helcocoris*, not seen in Malwa Tal, was found clinging to the under surfaces of stones on the margin of the lake.

Cladocera, aquatic insects and molluscs occurred in great abundance in a small pond lying above the level of the lake near its northern end.

BHIM TAL.

Owing to the fact that this lake has been dammed at its eastern corner and provided with sluices in connection with the water-supply, the level of the water and the area covered by it can be regulated artificially to a considerable extent. It was visited in October, 1907, and in May, 1911, and on both occasions the sluices were closed and the lake full.

Both sponges and polyzoa are fairly abundant in Bhim Tal; but the former grow less luxuriantly than in Naukuchia Tal, and the latter than in Malwa Tal. The following species were found:—*Ephydatia fluviatilis*, *Spongilla carteri*, *Plumatella diffusa*, *P. allmani*, *P. emarginata*, *P. tanganyikae*, *and Lophopodella carteri*. *Fredericella indica* was not obtained.

Of the sponges in this list only gemmules[1] were found in October, 1907; but growing specimens were collected in May, 1911

[1] Annandale, *Journ. As. Soc. Bengal*, 1907, p. 24.

Both sponges and polyzoa were found in greater abundance than elsewhere on branches of trees growing towards the north end of the lake, in an area left entirely dry when the sluices are opened. *Lophopodella carteri* appeared to be equally abundant on the two occasions on which the lake was visited; but *Plumatella allmani* was only taken in October, 1907, and *P. diffusa*, *P. emarginata* and *P. tanganyikae* in May, 1911.

Most of the specimens of *Ephydatia fluviatilis* exhibited a peculiar external modification; growing on narrow twigs, their base necessarily covered a narrow but elongated surface; in consequence their growth was mainly in a vertical plane, the best developed having the form of a large cockscomb.

Here, as in Naukuchia Tal and Malwa Tal, a small leech belonging to the genus *Glossosiphonia*[1] was found in considerable numbers. In May it was noticed that in small pools in the partly dried river bed at the north end of Bhim Tal, individuals of this leech were in the habit of attaching themselves to large water beetles belonging to the genera *Hydrophilus* and *Cybister*: as a rule to the former. The position chosen was invariably the apex of the dorsal surface of the elytra, where in some cases as many as four specimens were found. Leeches could not be discovered beneath the wing-cases and it is difficult to suggest any reason for the association of the two forms, except that leeches attached to water-beetles must have a considerable chance of escape from pools that are drying up, owing to the fact that the beetles have the power of flight. The species of the genus *Glossosiphonia* are known to feed chiefly, if not entirely, on soft bodied animals, and in the present case it was clear that they were unable to penetrate the hard integument of the insects. Mollusca were abundant in these pools, but only to one specimen, belonging to the genus *Limnaea*, was a leech attached

In Bhim Tal itself no large water-beetles appeared to exist. *Glossosiphonia* was found under stones round the margin of the lake, frequently with young ones of a pale green colour attached to the ventral surfaces. At least three other Hirudinea were found together with this form, one of them probably representing the genus *Limnatis*. In addition a small dark grey planarian was not uncommon.

As regards the plankton the most notable feature on both occasions was the enormous abundance of a *Ceratium*; but whereas in 1907 the form that occurred could be identified with *C. longicorne*, Perty, in May, 1911, the majority of the specimens agreed closely with Carter's original figure of *C. kumaonense*. It is obvious that much research on the Peridiniaceae of the Indian lakes is necessary before any statement can be made as regards the limits of the "species"—even of those already recorded.

1 Mr W. A. Harding has kindly informed us that this species is closely allied to the British *G. heteroclita* but probably represents a form hitherto undescribed. It is perhaps specifically identical with a species occurring in Calcutta but not as yet found in association with beetles in that locality.

Although there appears to be some evidence that these two forms are merely phases of one species, it is noteworthy that *C. kumaonense*, to use the name without prejudice, is the common form in Bhim Tal at a time of year at which *C. longicorne* predominates in other lakes situated in the same district and at approximately the same altitude.

SAT TAL.

This lake is situated about two miles west of Bhim Tal at a slightly greater elevation. Originally, as is implied by the name, seven lakes existed, but only two sheets of water of any considerable size now remain. The larger, Sat Tal proper, is U-shaped and in former times comprised two separate lakes; but a neck of shallow water now connects the large eastern part with the smaller, but much deeper, western part.

The fauna of Sat Tal is in some respects similar to that of Bhim Tal, but the plankton is poor and the *Ceratium*, found in such abundance in the latter lake, was (in May) almost entirely absent. Two species of sponge were found, *Ephydatia fluviatilis* and *Spongilla carteri*, the latter being very common. Of polyzoa, *Lophopodella carteri* was plentiful on the branches of trees growing in the eastern part of the lake and *Fredericella indica* was found in the same situation along with a few colonies of *Plumatella tanganyikae*. The water bug *Helcocoris*, noticed in Naukuchia Tal, was not uncommon; but other aquatic insects were, as usual, extremely scarce. Small leeches similar to those obtained in Bhim Tal occurred under stones on the margin of the lake.

The plankton was very scanty: a few copepods were found and *Peridinium apiculatum* was comparatively plentiful. The few examples of *Ceratium* that were obtained had the same form as those observed in Malwa Tal.

In May a small pool of water existed at the bottom of a deep ravine situated close to the weir at the north-west corner of the lake. This, as was found to be the case with the ponds in the vicinity of Bhim Tal and Naukuchia Tal, sustained an abundance of insect and molluscan life.

Gurud Tal, a small lake situated close to Sat Tal but at a slightly greater elevation, could not be examined systematically owing to the absence of a boat. Judging, however, from an inspection of the bank, its fauna did not appear to differ in any notable way from that of the larger lake.

NAINI TAL.

This, the largest of the Kumaon lakes, is situated at an elevation of about 6,400 ft., nearly 2,000 ft. higher than Bhim Tal; but notwithstanding its greater altitude the fauna did not present any considerable difference from that found in the lower lakes, though, on the whole, it appeared to be less rich.

In May almost all the margin was occupied by a dense belt of water-weeds, many of which possesed very long stems and grew from considerable depths. These weeds afforded support to large colonies of *Lophopodella carteri* and *Fredericella indica* and it was noticed that *L. carteri* invariably lived on the upper parts of the stems, extending to within a foot or so of the surface, while *F. indica* always occupied a lower position. Together with these polyzoa large colonies of Vorticellids were conspicuous, more particularly near the surface of the water. The only sponge observed was *Ephydatia fluviatilis*, which grew both on the stems of water-plants and on the under surface of stones on the western bank.

The scarcity of aquatic insects was again a very noticeable feature; but a leech of the predaceous family Herpobdellidae which seemed to be rare in the other lakes was not uncommon under stones.

In May the plankton was decidedly richer than in Sat Tal. Copepods were comparatively abundant and Rotifers of the family Anuraeidae were by no means uncommon. *Ceratium* was exceedingly scarce; the few specimens observed had the same form as those found in Malwa Tal.

At the northern end of Naini Tal, situated at an elevation of about 7,000 ft., there is a small temporary sheet of water bearing the name of Suka Tal. In May, 1911, this was completely dried up, but from earth brought back to Calcutta and placed in an aquarium a few Cladocera and Ostracoda were reared. It was in Suka Tal in October, 1906, and May, 1909, that specimens of an interesting Anostracous crustacean, *Pristicephalus priscus*, were obtained. This species, which has recently been described by Prof. von Daday,[1] seems to be restricted to the Western Himalayas. It has been found in two localities in the Simla Hills and, in addition to Suka Tal, at Bhowali, a village on the road between Bhim Tal and Naini Tal. In May, 1911, the species seemed to be entir ly absent from small pools in the vicinity of the Kumaon lakes, although it was abundant in 1907 in the same months near Simla. The erratic appearance and disappearance of the species of Branchiopoda is well known.

The table on the next page illustrates the distribution of Porifera and Polyzoa in the five principal lakes of the district. None of our specimens are from deep water, none having been procured rom a greater depth than about 6 feet.

[1] "Mon. Syst. Phyllopodes anostracés" (Ann. Sc. Nat. Zool. (Paris), 9e série, XI, p. 224, fig. 29; 1910).

	Malwa Tal, 3,600 ft.	Naukuchia Tal, 4,000 ft.	Bhim Tal, 4,450 ft.	Sat Tal, 4,500 ft.	Naini Tal, 6,470 ft.
PORIFERA—					
Ephydatia fluviatilis	..	C	+	+	+
Spongilla carteri	..	..	+	C	
Spongilla cinerea	..	+			
Spongilla lacustris subsp. *reticulata* ..	+				
Stratospongilla bombayensis var. *pneumatica*	..	C			
POLYZOA—					
Lophopodella carteri	+	..	C	C	C
Fredericella indica	C	..	..	+	C
Plumatella diffusa	+	..	+		
Plumatella allmani	+				
Plumatella emarginata	R	..	R		
Plumatella tanganyikae	..	..	+	R	
Stolella himalayana	R				

[C = common; + = present; R = rare.]

Imperfect as the above observations are, the following general conclusions as regards the fauna of the Kumaon lakes may be stated with some confidence:—

1. The zoo-plankton (more particularly the smaller crustacea) is, at any rate in the month of May, much more abundant in the small pools in the neighbourhood of the lakes than in the lakes themselves; this is also the case as regards aquatic insects.

2. Sponges and polyzoa are remarkably abundant in most of the lakes, but no specimens of the latter group were taken in Naukuchia Tal.

3. Both sponges and polyzoa, with a few exceptions (*e.g.* *Stolella himalayana*), contain numerous resting reproductive bodies in May. This agrees with what occurs in the plains of India, except that the production of these bodies is usually completed and the vegetative part of the organism has decayed about a month or six weeks earlier. It is very different from what occurs in European lakes, in which the resting reproductive bodies are usually found at the approach of winter.

4. Mollusca such as *Limnaea* and *Planorbis* reach a larger size in the small pools in the vicinity of the lakes than in the lakes themselves.

5. No species of Caridea occurs in the lakes. Decapoda are represented solely by two species of *Potamon* (*s. s.*).

6. A 'species' of *Ceratium* occurs in abundance in the lakes and exhibits great variation. One form of this "species" predominates in each lake at a given date (at any rate in May) but the predominant form is not always the same in different lakes at the same date.

PART II.—SYSTEMATIC AND GEOGRAPHICAL NOTES ON THE SPONGES AND POLYZOA.

By N. ANNANDALE.

PORIFERA.

1. SPONGILLA (EUSPONGILLA) LACUSTRIS subsp. RETICULATA, Annand.

This sponge was only taken in the lowest of the lakes, Malwa Tal (alt. 3,600 feet), in which it was abundant and bore numerous well-developed statoblasts in May. The race is widely distributed in the plains of India, in which it flourishes chiefly in wet weather.

2. SPONGILLA (EUSPONGILLA) CINEREA, Carter.

Specimens were taken in Naukuchia Tal (alt. 4,000 feet) in May. They formed a layer never more than about 10 mm. thick on twigs and are (in a dry condition) of a pale yellow colour. The oscula were small and to some extent radiate, and the skeleton-spicules a little more coarsely spined than in the type, in which the oscula are much larger and non-radiate. The dark greyish colour of Carter's specimens was probably due to their having grown in muddy water. Specimens from the R. Godaveri at Nasik and the R. Bhima at Khed in the Poona district were of a bright green colour but resembled those from Kumaon in the structure of the skeleton-spicules and oscula. Except for the specimens from Naukuchia Tal the species is only known from the Bombay Presidency, the specimens recorded by Prof. Max Weber [1] from the Malay Archipelago as *S. cinerea* actually representing not this species but *S. proliferens*, mihi.

3. SPONGILLA (EUNAPIUS) CARTERI, Carter.

Sponges were taken in Bhim Tal (alt. 4,450 feet) and Sat Tal (alt. 4,500 feet) in May and gemmules were found floating on the former lake in October. This is perhaps the commonest of the Spongillidae in India. The specimens from Kumaon bore well-developed gemmules in May, a month in which these bodies are also fully formed in the plains. At lower altitudes, however, the sponge has usually disintegrated by this date, whereas in Kumaon it was evidently still in declining vegetative vigour.

[1] *Zool. Ergeb. Niederl. Ost-Ind.*, vol. i, pp. 35, 46 (1890).

4. SPONGILLA (STRATOSPONGILLA) BOMBAYENSIS, Carter.

Specimens from Naukuchia Tal (alt. 4,000 feet) differ sufficiently from the typical form as found in Bombay and Mysore to be regarded as the types of a new variety for which, in the *addenda* to my volume in the *Fauna of British India* (p. 241), I have proposed the name *pneumatica*. Their most striking feature is the thick but irregular pneumatic coat superimposed on the gemmule outside the gemmule-spicules. They are also remarkable for possessing short vertical branches, and one specimen takes the form of a delicate cup attached by its base to a twig.

EPHYDATIA FLUVIATILIS subsp. HIMALAYENSIS, nov.

Ephydatia fluviatilis, Annandale, *Faun. Brit. Ind.*, Freshwater Sponges, etc., p. 242 (1911).

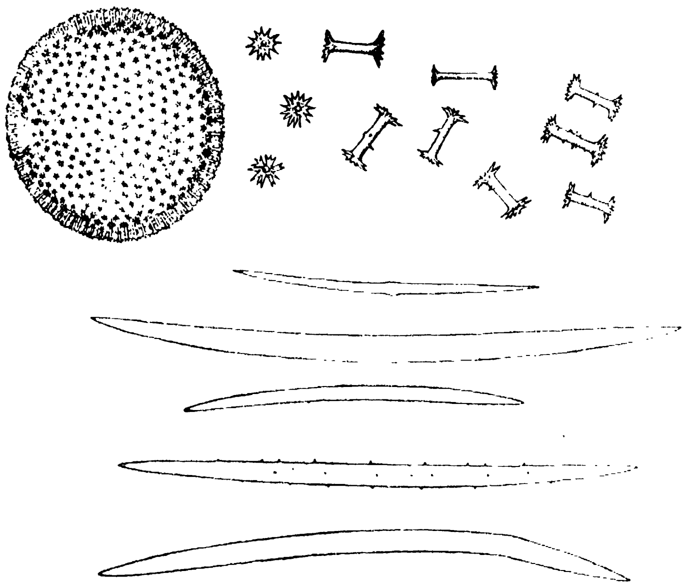


Fig. 1.—Gemmule (×75) and Spicules (×240) of *Ephydatia fluviatilis* subsp. *himalayensis*.

Specimens belonging to this common and widely distributed species were taken in May in several of the lakes, in which it appears to replace *E. meyeni*, Carter, the form common in the plains of India. In Naukuchia Tal, the water of which is remarkably clear, Mr. Kemp was able to see that they did not occur at depths much greater than 10 feet. Gemmules were also taken on the surface of Bhim Tal in October and were attributed to *E. robusta*[1] (Potts), which is probably only a variety of *E. fluviatilis*. The sponge from the lakes of Kumaon, however, although very

[1] Annandale, *Journ. As. Soc. Bengal*, 1907, p. 24, fig. 7.

near to *E. robusta*, exhibits certain peculiarities which seem to entitle it to be regarded as a distinct local race. For this new subspecies the name *himalayensis* is proposed. Many of the specimens are well preserved but I can detect no trace of "bubble-cells" in their parenchyma.

E. fluviatilis subsp. *himalayensis*, may be distinguished from the typical form of the species by the following characters:—

(i) The skeleton-spicules are very variable in length and usually rather slender. The majority are long.

(ii) Scattered amongst the smooth skeleton-spicules of the ordinary type there are a few particularly slender ones which have, widely and sparsely scattered over the middle region, a comparatively small number of very minute spines, the tips being always smooth.

(iii) The gemmule spicules are somewhat variable in proportions but as a rule rather shorter than is ordinarily the case in the species. Their rotulae are narrow and often almost regularly, although always deeply indented round the margin. The shafts are slender and either smooth or provided with a few comparatively short spines.

The external form of the sponge is very variable and seems to depend to a large extent on the nature of the object to which it is attached. Specimens growing on slender twigs at the surface form a compressed crest like a cockscomb, those attached to stones at the bottom spread out in a flat film of little depth, and those fixed to delicate water-weeds form irregular nodules. No large specimens were obtained, none having a superficial area of more than a few square centimetres. The specimens (dry and in spirit) have a faint yellowish colour. They contained (in May) numerous well formed gemmules.

Habitat.—Kumaon, W. Himalayas: Naukuchia Tal (4,000 feet), Bhim Tal (4,450 feet), Sat Tal (4,500 feet) and Naini Tal (6,400 feet) (*Kemp*, May, 1911).

In the possession of spined skeleton-spicules *E. fluviatilis* subsp. *himalayensis*, resembles a form of the species which Weltner[1] has recently described from Issyk-Kul in Turkestan. It does not possess, however, the monstrous amphistrongyli of the latter and appears to have less spongin in its skeleton. The external surface is also smoother and the canals are less capacious

POLYZOA.

The following is a list of the polyzoa taken in the Kumaon lakes; the species have been described in my volume on the Fresh-

[1] "Beiträge zur Kenntniss der Fauna Turkestans—viii. Spongillidae des Issyk-Kul-Sees und des Baches bei Dschety-Ogus." *Travaux de la Société Imp. des Naturalistes de St. Pétersburg*, xlii, p. 63, text figures 8-39, and pl I, figs. 1-7 (1911).

water Sponges, Hydroids and Polyzoa in the "Fauna of British India," but it now seems necessary to regard one (*Plumatella tanganyikae*) as the type of a new subgenus.

1. FREDERICELLA INDICA, Annandale.

Taken by Mr. Kemp in Malwa Tal, Sat Tal and Naini Tal (3,600–6,400 feet) in May. The specimens from the Himalayas differ from those on which the original description of the species was based (from lakes in the W. Ghats near Bombay and in Travancore) in their much more luxuriant growth. They form dense bushy masses, in some cases with vertical branches as much as 3·5 cm. long. The type specimens were, however, taken in November and were evidently just re-assuming active growth after a period of quiescence.

I have recently (March 2nd, 1912) found this species growing with fair luxuriance on the leaves of *Vallisneria spiralis* in a canal at Cuttack in Orissa. Some of the zoaria contained statoblasts; in others they were absent. The ectocyst was paler in colour than in Mr. Kemp's Kumaon specimens.

2. PLUMATELLA EMARGINATA, Allman.

Bushy masses of this common and universally distributed species were taken in May in Malwa Tal and Bhim Tal.

3. PLUMATELLA DIFFUSA, Leidy.

Common in Malwa Tal and Bhim Tal in May: one of the few species as yet taken in the plains of North-Western India.

4. PLUMATELLA ALLMANI, Hancock.

Taken in Malwa Tal in May by Mr. Kemp and in Bhim Tal in October by myself. Specimens from these lakes show every gradation between the form originally described by Hancock and Allman's *P. elegans*; they possess, however, an apparent peculiarity in coloration in that the older zooecia are invariably surrounded by a band of dark pigment near the middle.

AFRINDELLA, subgen. nov.

This subgenus is distinguished from *Plumatella* (*s.s.*) by the manner in which the orifice is closed when the polypide retracts its lophophore. The stiffened ectocyst of the zooecium, instead of merging gradually into the much softer and more flexible tentacle-sheath, terminates abruptly and the tip of the zooecium therefore becomes truncate—as a rule obliquely truncate, because the stiffened ectocyst is produced at the dorsal end of the periphery, which is oval in outline, further than at the ventral. Immediately following the sharply defined orificial margin thus produced and in direct

continuity with it, the dorsal end gives rise in some zooecia to a small semicircular projection or hood even darker than itself but somewhat more flexible. At each side of the periphery a projecting valve, which is colourless, softer and still more flexible, is formed in continuation of the stiffened wall, and the two valves are joined together round the ventral end by a narrow fringe of integument similar to that of which they are themselves formed. The terminal wall of the zooecium may therefore be said to be surrounded for the greater part of its extent by a projecting fringe or border the surface of which has the roughened appearance characteristic of the external ectocyst, although the colour and stiffness of the latter are absent. Although I talk of this structure as a projecting border, its distal margin is, as a matter of fact, in direct continuity with what becomes the proximal end of the tentacle-sheath when the polypide is fully extended, just as its proximal margin is in continuity with the wall of the zooecium.

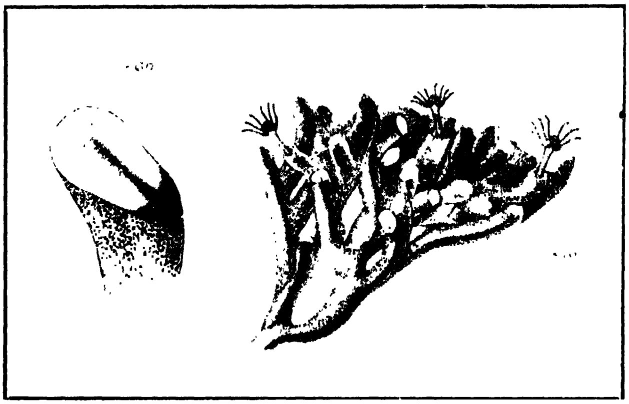


Fig. 2.—Part of zoarium of *P. tanganyikae* from Cuttack, × 10, with the tip of a single zooecium, × 60.

When the polypide retracts its lophophore, the hood (when it is present) is drawn downwards to a slight extent, owing to the fact that it is attached distally to the tentacle-sheath, and bends over the orifice. For the same reason the lateral valves close together tightly, completely covering the orifice. If retraction of the lophophore is spasmodic or unusually violent the valves are dragged into the zooecium so far that a kind of antechamber is formed above them, of course open at the tip. When the lophophore is extended, the valves are thrust apart and the hood is forced into line with the end of the orificial wall. Before the tentacles emerge, however, a bulbous transparent mass appears between the valves and forces them asunder. It is the still partially-invaginated tentacle-sheath.

It was not until I had had an opportunity of examining at leisure with a binocular microscope healthy living colonies of

Plumatella tanganyikae that I realized the complexity of the opercular apparatus in this species, but once this had been realized, it was not impossible to trace the same structures in preserved specimens from both Africa and India, although the much paler colour of the ectocyst in the former made the observation more difficult than it was in the case of Indian examples of the species. The peculiarities described in the preceding paragraphs would fully justify the recognition of *P. tanganyikae* as the type-species of a distinct genus, were it not for the fact that the different species of *Plumatella* (*s. s.*) exhibit considerable variation in respect to the manner in which the orifice is closed. In those species (*e.g.*, *P. repens* and *P. fruticosa*) in which the zooecial wall is fairly flexible and there is no furrow along its dorsal surface, the polypide is merely withdrawn by the retractor muscles, in the same way as the tip of the finger of a glove might be withdrawn by pulling strings attached to its internal surface. The walls of the zooecium collapse together and the result is a rounded tip with a minute round aperture in the middle. In those species, however, (e.g., *P. emarginata* and *P. diffusa*) in which the external ectocyst is somewhat inflexible, a furrow (that is to say, a narrow longitudinal area on which the ectocyst is thinner and softer) extends from the orifice along the dorsal surface of the zooecium and forms at one end the dividing line between valves not dissimilar to those which close together over the tentacle-sheath in *P. tanganyikae.* The lophophore emerges between them just as it does in that species. In *P. tanganyikae* there is usually no furrow on the distal end of the zooecium proper, although there often is one on the proximal part; but occasional zooecia may be found in which, in the absence of a dorsal hood, the soft integument of the valves and the separation between them extend for a short distance along the dorsal surface of the zooecium. Even in such zooecia, however, the separation between the stiff zooecial wall and the soft opercular part of the ectocyst is much more clearly defined than it ever is in such species as *P. emarginata.*

P. tanganyikae must be recognized as the type-species of the new subgenus *Afrindella*, for it is not certain, though highly probable, that a similar method of closing the zooecium occurs in Kraepelin's *P. philippinensis*, which in other respects appears to be closely related.

5. PLUMATELLA (AFRINDELLA) TANGANYIKAE, Rousselet.

P. tanganyikae, Rousselet, *P.Z.S.*, 1907 (1), p. 252, pl. XIV, figs. 1-4

P. bombayensis, Annandale, *Rec. Ind. Mus.*, II, p. 169, figs. 1, 2.

P. tanganyikae, *id. Faun. Brit. Ind.*, Freshwater Sponges, etc., p. 225.

I do not think that the form I described as *P. bombayensis* can be distinguished specifically from Rousselet's African species,

as intermediate specimens occur; but Indian specimens represent a distinct race for which the name *bombayensis* must stand. Mr. Kemp found this species somewhat sparingly in Bhim Tal and Sat Tal in May. His specimens have a peculiar reddish colour and their zooecia are longer and slightly less recumbent than those from the W. Ghats. They were attached to small stones.

I have recently (March 2nd, 1912) found several colonies of this species growing, together with *Fredericella indica*, on the leaves of *Vallisneria spiralis* in a canal at Cuttack in Orissa. They resembled those found on the lower side of stones from Igatpuri but were evidently young.

It is curious that no species of *Plumatella* with broad statoblasts (except the aberrant *P. punctata*, Hancock) has as yet been found in India. Braem[1] has recently described (together with a new species of *Victorella*) a form allied to, if not identical with, *P. fungosa* (Pallas) from Issyk-Kul in Turkestan, but I know of no similar form in this country.

6. STOLELLA HIMALAYANA, Annandale.

Annandale, *Faun. Brit. Ind.*, Freshwater Sponges, etc., p. 246, fig. 49.

This species is described and figured in the *addenda* to my volume in the "Fauna" (p. 246, fig. 49) from specimens taken by Mr. Kemp in Malwa Tal in May. At that season the species was evidently scarce, but the zooecia contained few statoblasts (only free ones) and numerous young colonies were being formed by the budding of old statoblasts on the stones to which the adult zoaria were attached.

S. himalayana differs from *S. indica*,[2] the type species of the genus, in the following characters:—(i) the zooecia are entirely recumbent; (ii) each zooecium is separated from all others by the stolon-like prolongation of their bases; and (iii) the zoarium produces lateral branches almost in a cruciform manner.

7. LOPHOPODELLA CARTERI (Hyatt).

I found this species fairly common in Bhim Tal in October and Mr. Kemp took it in great profusion in the same lake and in Malwa Tal and Sat Tal in May. At both seasons statoblasts were being produced in large numbers, but in my specimens a large proportion of these were more or less ill-formed, the hooked processes being deficient or obsolete. These specimens were made the types of my variety ***himalayana***. Mr. Kemp's were, however, quite normal. *L. carteri* was originally found in the island of Bombay and is abundant in November in Igatpuri lake in the

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[1] "Beitrage zur Kenntniss der Fauna Turkestans—viii. Bryozoen und deren Parasiten," *Trav. Soc. Imp. Naturalistes St. Petersbourg*, vol. xlii, p. 5, figs. (1191).

[2] *Rec. Ind. Mus.*, iii, p. 279, fig. (1909). Professor K. Ramunni Menon of Madras has recently sent me specimens of *S. indica* from that city.

W. Ghats. A record of "*Lophopus*" from Madras may actually refer to this species, statoblasts of which have been found in German East Africa. A race (*davenporti*, Oka) occurs in Japan and is distinguished by the stronger development of the hooked processes at the ends of the statoblasts.

GEOGRAPHICAL DISTRIBUTION OF THE SPECIES.

The following list shows practically all that is known of the distribution of the sponges and polyzoa that have been found in the Kumaon lakes, at any rate so far as India is concerned. It would seem to provide evidence that the aquatic fauna of the Malabar Zone [1] is less restricted than it at one time appeared to me. Recent investigations, however, undertaken in different parts of India, prove that the African element which is so marked a feature of that fauna is more widely distributed in India than was at first realized. In particular, a species (a somewhat peculiar species, it is true) of *Corvospongilla* has been found in the Ganges valley,[2] while both *Fredericella indica* and *Plumatella tanganyikae* have been discovered in the main Peninsular Area of India. It is noteworthy that the Gangetic *Corvospongilla* differs from its congeners in having free statoblasts provided with a well-developed pneumatic layer, but a species of the genus more typical in this respect (*C. ultima*)[3] has also been found at Tanjore far to the east of the Western Ghats.

[1] See Alcock, *Cat. Ind. Dec. Crustacea Ind. Mus.*, part i, fasc. ii (Potamonidae), 1910; also the general introduction to my volume on the Freshwater Sponges, etc., in the *Fauna of British India*. p. 10.

[2] Annandale, *op. cit.*, p. 243.

[3] This species is wrongly attributed to *Spongilla* in the "Fauna" (p. 105).

Geographical Distribution of the Sponges and Polyzoa of the Kumaon Lakes.

[Forms of which the names are marked with an asterisk are apparently peculiar to the lakes of Kumaon.]

Name of Species.	Malabar Tract.	Peninsular India (Main Area).	Indo-Gangetic Plain.	Distribution outside India.
SPONGES.				
Spongilla lacustris subsp. *reticulata*.	Igatpuri, W. Ghats ..	Madras, etc. ..	Gangetic delta ..	Typical form of the species widely distributed in Europe, N. Asia and America.
Spongilla cinerea ..	Bombay (island); Igatpuri; Poona district.	....	....	....
Spongilla carteri ..	Many localities ..	Many localities ..	Many localities ..	Mauritius: Malay Archipelago: E. Europe; ? Central Africa.
Spongilla bombayensis var. *pneumatica* *	Bombay (island); Igatpuri (*typical form*).	Bangalore (*typical form*) ..	....	Natal, S Africa (*typical form*).
Ephydatia fluviatilis subsp. *himalayensis*.*	....	....	....	Europe: America; N. Asia (*typical form*) Turkestan (? *var.*); S. Africa (*var*).
POLYZOA.				
Fredericella indica ..	Igatpuri, W. Ghats; Travancore (plains).	Cuttack, Orissa	....	A specimen from N. Assam may belong to this species, but it is doubtful even whether it is *Fredericella*.
Plumatella emarginata ..	....	....	Gangetic delta ..	Europe, N. America, etc.
Plumatella diffusa ..	....	....	Gangetic delta, etc. ..	Europe, N. America
Plumatella allmani	....	....	....	England.
Plumatella (*Afrindella*) *tanganyikae*.	Igatpuri, W. Ghats ..	Cuttack, Orissa ..	....	Central Africa (L. Tanganyika).
*Stolella himalayana** ..	....	....	....	...
Lophopodella carteri ..	Bombay (island): Igatpuri.	? Madras	....	E. Africa (*typical form*); Japan (*subspecies*).

XV. FAUNA SYMBIOTICA INDICA.

No. 3.—POLYZOA ASSOCIATED WITH CERTAIN GANGETIC TORTOISES.

By N. ANNANDALE, *D.Sc., F.A.S.B., Superintendent, Indian Museum.*

(Plate XIII.)

It was noticed that peculiar lichenoid patches were present on the carapaces of a number of tortoises captured in the Ganges near Rajmahal in March, 1912, by Mr. B. L. Chaudhuri and brought alive to Calcutta At first sight the patches were taken for algae, but a close examination showed that they were formed of one or both of two species of polyzoa, namely *Hislopia lacustris* and an undescribed form of *Plumatella* closely allied to *P. tanganyikae*. The tortoises in the collection belonged both to the Testudinidae and the Trionychidae, the former being represented by three species of *Kachuga* (*K. dhongoka, K. lineata* and *K. smithii*) and one of *Hardella* (*H. thurgii*), while the Trionychidae comprised *Trionyx gangeticus* and *T. hurum*. The polyzoa were not found on either species of *Trionyx* or on *K. smithii* (a small species), but one or both occurred on most of the larger specimens of Testudinidae. Probably the skin of the mud-turtles is too soft and slimy for their proper attachment or growth.

The tortoises had been out of the water for at least twenty-four hours before they were examined and the polypides of the polyzoa had perished, but fortunately the zooecia remained in sufficiently good condition for an investigation of the general structure and specific characters.

HISLOPIA LACUSTRIS, Carter.

Annandale, *Faun. Brit. Ind.*—Freshwater Sponges, etc., pp. 190, 200—205, figs. 35A, 38 and 39.

The zoaria on the tortoises' shells each cover an area of several square inches and are of luxurious growth, almost every zooecium producing its full complement of three buds and the whole colony being closely compacted. without, however, the zooecia overlapping. The individual zooecia are small, measuring on an average slightly over 1 mm in length and being very variable in breadth ; they are as a rule irregularly polygonal in outline and have the proximal end narrower than the distal. The orifice is circular or subcircular and as a rule lacks spines, although it

has a well-marked chitinous border. The zooecia are too closely fitted together for a flat membrane to intervene, but their chitinous margins are well developed.

Most of the zoaria in the collection had been overgrown by the Phylactolaematous species next to be described. They were only found on the carapace of *Hardella thurgii* in this instance, but *Hislopia lacustris* commonly occurs on the shells of molluscs of the genus *Vivipara* as well as on the leaves of *Vallisneria spiralis*, on logs, stones and other inanimate fixed or floating objects. Major Walton discovered the polyzoon *Stolella indica* growing over large zoaria in the United Provinces and the bases of the type-specimens of the sponge *Corvospongilla burmanica* from Pegu contained the remains of zooecia. The species is widely distributed in the tropical parts of eastern Asia.

PLUMATELLA (AFRINDELLA) TESTUDINICOLA, sp. nov.

Zoaria forming quite flat, oval or circular lichenoid patches with undulating or sinuous borders and in some instances as much as 10 cm. in diameter; consisting of zooecia laying parallel and closely adjacent in one plane and radiating in branches from a common centre.

Zooecia entirely recumbent, narrow, elongate, with the orifice opening almost vertically; the proximal part a little flattened, without dorsal keel or furrow the ectocyst densely covered with minute sand-grains, translucent brownish, indistinctly annulated, paler on the distal than on the proximal part.

Polypide not observed.

Statoblasts. Only fixed statoblasts are apparently developed. They occur in great profusion, entirely filling many dead zooecia and arranged in moniliform series. As the dorsal wall of the zooecium decays they are left adhering with its ventral wall to the host's carapace and reproduce the pattern of the zooecium, often almost completely. They are, as a rule, broadly oval, measuring about 0·52 × 0·35 mm., but sometimes they are circular and occasionally kidney-shaped. The surface is polished and without a trace of reticulation and the capsule is surrounded by a stout chitinous ring separated from it by a deep peripheral groove; the colour is black or very dark brown.

Localities and hosts.—R. Ganges near Rajmahal, on carapace of *Hardella thurgii*, *Kachuga dhongoka* and *K. lineata*: staloblasts also observed on young specimens of *K. dhongoka* from Allahabad and Fatteghar.

The structure of the zooecium closely resembles that of the zooecia of some forms of *Plumatella tanganyikae*, which I have recently adopted as the type-species of the new subgenus *Afrindella* (Rec. Ind. Mus., vii, p. 140) and I have little doubt that I am right in referring the new species to that subgenus. It is unfortunate, however, that the polypides of the type-specimens are not in a fit state for examination. The statoblasts somewhat

resemble those of *Fredericella*, to which belong the only species hitherto described in which all of these bodies are devoid of a ring of air-cells. The fixed statoblasts of *Plumatella*, however, always resemble those of *Fredericella*, and that to a different extent in different species. It is probable in the present instance that the production of fixed statoblasts only is an adaptation correlated with the peculiar method of life adopted by the polyzoon. As the tortoises to which it is attached leave the water for purposes of oviposition, if not for other purposes also, it is perhaps necessary that the *Plumatella* should not altogether lose their services as beasts of burden at any period in its life-cycle, solid objects to which it can affix itself being few and far between in the mud of the Ganges.

In its general appearance *P. testudinicola* bears a remarkable but of course quite superficial resemblance to certain Cheilostomes and Ctenostomes that encrust flat surfaces. The method of budding is, however, completely different, for the closely compacted parallel branches of the zoarium are produced by linear budding or by the production in the first instance of two divergent buds at the tip of a parent zooecium. Except at and near the centre (which is the oldest part of the zoarium) there is no organic connection between the different branches, which, at any rate near the periphery, merely lie alongside one another. In the older parts of the colony it is clear that the production of divergent buds in the position indicated has been frequent but that they, or rather the branches produced from them by linear budding, have become closely pressed together and therefore parallel, not apparently having the power of raising themselves from the basis to which they adhere. Thus the method of budding differs from that of such forms as *Membranipora* and *Hislopia* in that lateral buds are never produced, while there is no single zooecium from which the branches radiate outwards as in *Flustrella* and many other encrusting forms. Indeed, it seems probable that each apparent colony is not really a single zoarium but rather the result of budding on the part of a group of statoblasts or embryos from each of which branches have been produced in one or in two directions. In *Plumatella tanganyikae*, although compact flat zoaria are often found, it is always possible to see that their branching is fundamentally bilateral and probably arises from the fact that the two first polypides produced from a single statoblast or embryo have diverged from one another before fixation was completed. In *P. testudinicola*, on the other hand, each colony appears to have arisen from a group of separate but closely adjacent individuals, the branches of which have been forced to diverge by mutual pressure. It is, however, difficult to be quite sure of this without studying young growing zoaria, which I have not seen, as the central part of old zoaria is always in a more or less decayed condition.

My specimens of the new species were taken in March, and it is evident that the vegetative phase of their life-cycle was practi-

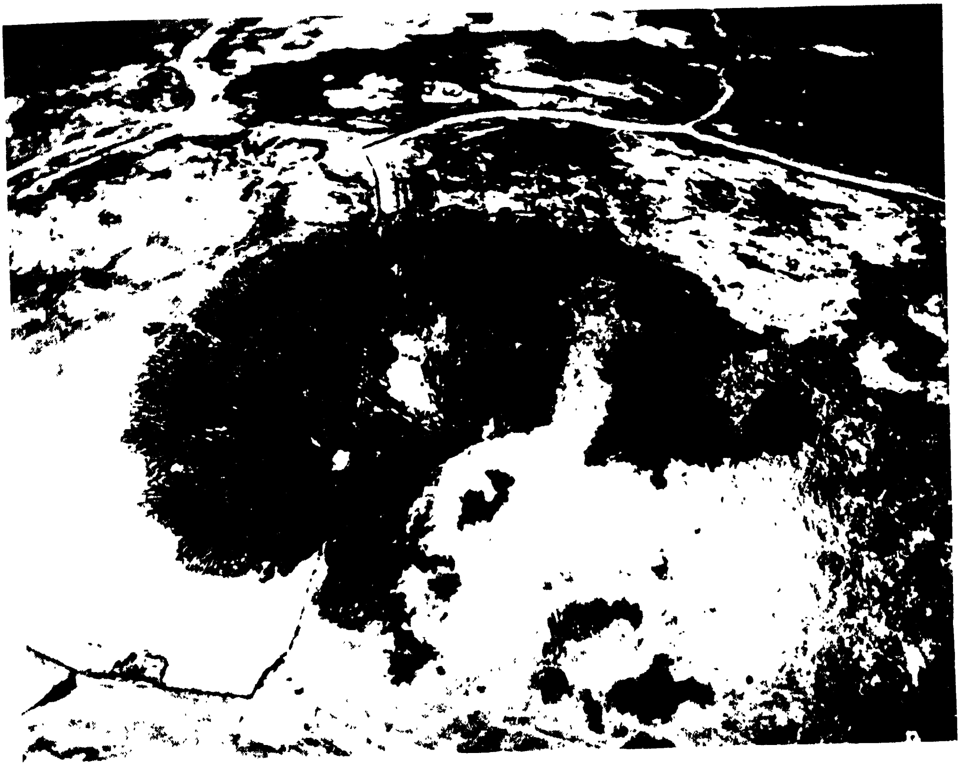
cally complete, statoblasts being produced in large numbers. *P. testudinicola*, like so many other Indian representatives of the Phylactolaemata, would appear, therefore, to be essentially a cold-weather form. On *Hardella thurgii* the zoaria grew over those of *Hislopia lacustris* and the zooecia were much less regular in their arrangement than when they were alone. The smooth shell of *Kachuga lineata* seemed, on the other hand, to encourage the production of the regularity and parallel growth so characteristic of the branches of the species.

EXPLANATION OF PLATE XIII.

Photographs of the type-specimens of *Plumatella (Afrindella) testudinicola* on the carapace of *Kachuga lineata.*

FIG. 1.—The whole zoarium (*nat. size*).

" 2.—The central part of the same zoarium (*enlarged*), showing statoblasts (s) *in situ.*



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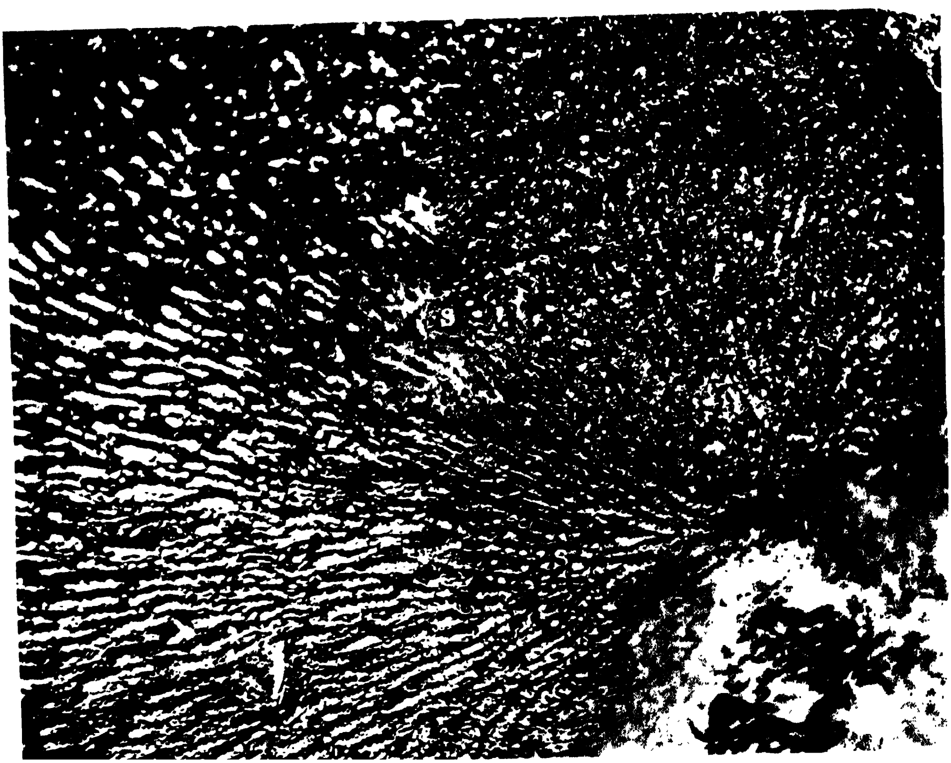


XVI. THE INDIAN MUD-TURTLES (TRIONYCHIDAE).

By N. ANNANDALE, *D.Sc.*, *F.A.S.B.*, *Superintendent, Indian Museum.*

(Plates V—VI.)

The main object of the present paper is to supplement Mr. G. A. Boulenger's admirable account of the Indian Chelonia published in the volume on Reptilia and Batrachia in the "Fauna of British India." It is now twelve years since this volume appeared and although additions to our knowledge of the Trionychidae since that date have not been very numerous or important so far as India is concerned, the fact that its author had not access to the bulk of the large collection accumulated in the Indian Museum by the late Dr. J. Anderson and his contemporaries and successors rendered certain omissions unavoidable.

I have been able, moreover, to institute special inquiries into the distribution of certain species and races and have received assistance in so doing from several naturalists in different parts of India, especially from Dr. J. R. Henderson, Superintendent of the Madras Museum, and from my colleague Mr. B. L. Chaudhuri, who has supplied me with valuable information.

One species and two subspecies not recognized by Mr. Boulenger in the "Fauna" are here described. The species belongs to the genus *Trionyx* and is interesting because it represents this genus in a geographical area in which information about its distribution was peculiarly scanty.

This *Trionyx* was described, it must be confessed inadequately, by Dr. Anderson, who named it *T. nigricans.* It inhabits a tract of country intermediate between the Brahmaputra river-system and the Arrakan streams in which a Burmo-Malay species of the genus first makes its appearance. I have found it necessary, moreover, to recognize the races of *Emyda* that occur in Chota Nagpur and Orissa on the one hand and in Ceylon on the other as distinct subspecies. The name *intermedia* is here proposed for the former race, while Gray's "*ceylonensis*" is available for the latter.

LIST OF THE INDIAN TRIONYCHIDAE.

1. Dogania subplana (Geoffr.). Mergui, Malay Peninsula, Sumatra, Sinkep I., Java, Borneo, and the Philippines.

2. Trionyx gangeticus, Cuvier.	The river-systems of the Indus, the Ganges and the Mahanaddi.
3. ,, leithii, Gray. ..	The rivers of western, central, and northern India.
4. ,, hurum, Gray. ..	The lower reaches of the Ganges; the Brahmaputra as far east as its entry on the plains.
5. ,, nigricans, Anderson.	Chittagong.
6. ,, formosus, Gray. ..	The Irrawaddi, the Sittang and the Salween.
7. ,, phayrei, Theobald.	Arrakan, Pegu, Tenasserim, the Malay Peninsula, Sumatra, Java, and Borneo.
8. ,, cartilagineus (Boddaert).	Pegu, Tenasserim, Siam, Cambodia, the Malay Peninsula, Sumatra, Borneo and Java.
9. Pelochelys cantoris (Gray).	The lower Ganges system, Burma, the Malay Peninsula, Annam, S. China, Borneo, Sumatra, the Philippines and New Guinea.
10. Chitra indica (Gray). ..	The Ganges and Irrawaddi system, as far as the base of the Himalayas in the former.
11. Emyda granosa (Schoepff).	The valleys of the Indus and the Ganges; the Arrakan Coast.
11*a*. ,, ,, intermedia, nov.	Chota Nagpur; the Central Provinces; Orissa and the north-east of the Madras Presidency.
11*b*. ,, ,, vittata, Peters.	The greater part of the Bombay Presidency (including Cutch); the whole of the Madras Presidency except the north-eastern part; Travancore.
11*c*. ,, ,, ceylonensis, Gray.	Plains of Ceylon.
11*d*. ,, ,, scutata, Peters.	The valleys of the Irrawaddi and the Salween.

From the above list it will be seen that the Trionychids of the Indian Empire fall naturally into three groups, if considered from a geographical point of view:—(1) those of the Indo-Gangetic and Brahmaputra river-systems; (2) those of the valleys of the rivers of Peninsular India, and (3) those of Burma.

The exact limits of these areas are, however, not strictly observed, for while the typical form of *Emyda granosa*, a characteristic Indo-Gangetic race, ranges in a south-easterly direction as far as the Arrakan Coast, the common Indo-Gangetic *Trionyx* (*T. gangeticus*) is apparently not only replaced in Arrakan by

T. phayrei but also separated from that species in Chittagong by *T. nigricans*, in many respects an intermediate form. Very little information is as yet available about the exact distribution of the South Indian species of *Trionyx*, but we now know that an Indo-Gangetic species (*T. gangeticus*) occurs in the Mahanaddi.

Both the southern race of *Emyda granosa* (subsp. *vittata*) and the northern or typical form have been found to be different from that which occurs in the Central Provinces and Chota Nagpur and inhabits even the valleys of rivers such as the Kasai and the Barakar which actually reach the sea through the Hughli estuary, south of the Hughli itself.

The Burmese forms are either endemic or found also in the Malay Peninsula, except the monotypic genus *Chitra* which has only been found in the Ganges and the Irrawaddi. *Trionyx formosus* is only known from the Irrawaddi, the Salween and the Sittang; *Emyda granosa scutata* only from the valleys of the two former rivers, while *Dogania subplana* and *Trionyx cartilagineus* are typical Malayan forms. *T. phayrei*, on the other hand, in all probability originated in the hills of Arrakan and has made its way southwards into the Malay Peninsula and certain islands of the Malay Archipelago and eastwards into Indo-China.

Only one of the Indian Trionychids has a really wide geographical range in both the Malayan and Indian sub-regions, namely *Pelochelys cantoris*. This appears to be a somewhat scarce species wherever it occurs, although it has been found both in the lower reaches of the Ganges and in New Guinea, as well as in many intermediate localities.

In preparing these notes I have not thought it necessary to give detailed reference to all the works that have appeared before or since the publication of Mr. Boulenger's volume in the "Fauna." To do so in respect to previous works is needless except in a few instances, whereas a full bibliography of recent references can be extracted from Dr. F. Siebenrock's "Synopsis der rezenten Schildkröten" (Zool. Jahrbucher, Jena, 1909). I have referred to this most useful work throughout simply by the author's name with the page number added.

Genus DOGANIA, Gray (1844).

Siebenrock, p. 605.

This genus, which is not recognized by Mr. Boulenger (at any rate in the "Fauna") as distinct from *Trionyx*, has the whole series of costal plates separated by neurals, instead of having the last pair of costals in contact in the middle line. The plastron [1] is also less fully ossified than in *Trionyx* in a restricted sense, and the branchial skeleton differs in that the basihyoid bones are in close contact in the middle line.

Only one species, which is widely distributed in Malaysia and occurs in the coastal districts of Burma, is known to exist.

[1] Siebenrock, S. B. K. Akad. Wiss. Wien, CXI, pp. 817—8, fig. 2, 1902.

1. Dogania subplana (Geoffr.).

Boulenger, Fauna, p. 9.

DISTRIBUTION.—Arrakan, Tenasserim, Mergui Archipelago, the Malay Peninsula, Sumatra, Java, Borneo, and the Philippines.

SPECIMENS:

BURMA.

11589 (spirit): juv. ..	Tibu, King I., Mergui Archipelago.	.. *Dr J. Anderson.*
13468-9 (stuffed): juv.	,, ,,	,, ,,
661 (spirit): juv. ..	"Sinkep I., off E. Coast of Sumatra"	.. *J. Wood-Mason.*

The two specimens in spirit are very young; their coloration has been obscured by fading but six rather small ocelli can still be distinguished on the disk, while the head and neck bear traces of longitudinal markings. The stuffed specimens from Mergui are probably half-grown, the disk measuring about 23·6 cm. in length. These and the young individual in spirit from the same district are referred to by Dr. Anderson in his "Fauna of the Mergui" (Jour. Linn. Soc. Zool., xxi. p. 342).

Mr. H. C. Robinson informs me that this is a purely estuarine and marine species.

Genus TRIONYX, Geoffr. (1809).

Boulenger, Fauna, p. 10 (*partim*): Siebenrock, p. 595.

This genus, which is by far the largest in the family and occurs in the warmer parts of all the continents except Europe, is well represented in the Indian fauna, to which at least eight species can be assigned.

The species are difficult to recognize, unless cranial and skeletal characters are considered as well as coloration. The lower jaw in particular affords diagnostic features of great importance in most species.

The branchial skeleton of this genus is less fully ossified and less complex than in some genera of the family. I have been able to find specific differences in it in some species. The basal part consists in the adult of three pairs of bones, a pair of basihyals in front, followed by two pairs of basibranchials. The basihyals are widely separated by a cartilaginous plate in which small irregular ossifications sometimes occur; their external margins are somewhat protuberant anteriorly but do not form regular horns. The basibranchials are in close contact in the middle line; the large cornua are articulated to prominent condyles situated on their external margins. The hypobranchials are well developed. They are articulated to the posterior border of the posterior basibranchials. The ceratobranchials and pterygobranchials are sometimes represented by cartilage, sometimes ossified.

An examination of the fine collection accumulated in this museum by the late Dr. John Anderson renders it necessary to reinstate one species (*T. nigricans*) inadequately described by him and since ignored by most writers on the Chelonia. All the recognized Indian and Burmese species are represented in the Indian Museum, but *T. leithii* and *T. cartilagineus* only by young specimens. We possess the types of the following described species :—

T. buchanani, Theobald. (= *T. hurum*, Gray). No. 1090 (skeleton). Proc. As. Soc. Bengal, 1874, p. 78.

T. nigricans, Anderson. Nos 1898 and 735 (skeletons). Ann. Mag. Nat. Hist., (4) XVI, 284 (1875).

Mr. Boulenger suggests in his "Catalogue of the Chelonians, etc. in the British Museum" (p. 243) that at least some species of *Trionyx* are dimorphic, the two phases differing in the form and structure of the jaw and their characteristic features being produced, in the case of the individual, by the method of obtaining food adopted at an early age.

So far as the Gangetic species are concerned I have been unable to obtain any evidence that this is so. Two distinct species, the skulls of which are different at all ages, occur together, namely *T. gangeticus* and *T. hurum*. The former has a blunt, the latter a sharp snout; and the youngest skulls can be distinguished with ease by the length of the symphysis of the lower jaw. I have examined many hundreds of living individuals, as well as a large series of skulls, and have never come across a specimen that was in any way intermediate between the two species in structure; while only one specimen of *T. hurum* (No. 16627) had some resemblance to *T. gangeticus* in colour, or rather differed so widely in this respect from normal individuals of its own species that its superficial appearance was reminiscent of *T. gangeticus*, although it lacked the characteristic head-markings of that species.

A not uncommon abnormality in the Indian species is an upward curvature of the vertebral column that results in the carapace, instead of being flat, assuming a conical form and actually in some instances being deeper than it is broad. The presence of a deep groove on the middle line of the carapace is another common abnormality.

The nature of the food of the members of the genus is apparently a disputed point. So far as my own observations go, they are practically omnivorous, at any rate when living in a semi-domesticated state. In the Malay Peninsula certain individuals (probably of *T. cartilagineus*) haunt rivers in the vicinity of villages and act as scavengers. The specimens of *T. formosus* that are kept in the Arrakan Pagoda at Mandalay feed readily on curry and rice and those of (?) *T. hurum* that live in somewhat similar conditions in a tank attached to one of the temples at

Puri in Orissa, eat sweetmeats made of parched rice and palm-sugar. In such conditions they grow very tame and come to feed when called. Those at Puri are popularly believed to be the descendants of a man named Gopal who offended Juggernaut; they are summoned by the priests by this name, to which they answer sometimes but by no means always—by appearing on the surface and swimming towards the edge of the tank.

The distribution of the Indian species of *Trionyx* is a matter of considerable interest but one in need of further elucidation, especially in respect to the species that occupy the rivers of western and southern India. There can be no doubt that one species (*T. gangeticus*) occurs both in the Indus and the Ganges, but whether this is the only form that will be found in the former river we do not know. Whether *T. leithii* is to be found in all the rivers of western, central and northern India we do not know. What species occur, if any do occur, in the rivers that water the southern and south-western parts of the Madras Presidency, and whether any species occur in Ceylon are questions that I have been unable to solve.

In the Gangetic delta, and I believe in the other parts of India *Trionyx* is regarded as an important article of diet. Very large numbers are caught, chiefly in the Khulna district, for the Calcutta market and are sent to town by train. They are captured in nets in autumn, when the rivers begin to sink, and are stored in the vicinity of Calcutta in small ponds, their fore and hind feet being sewed together and a hole, to which a string is attached, bored in the cartilaginous part of the disk. In this condition they live for many months. The only species I have actually seen treated in this way are *T. hurum* and *T. gangeticus*, but I understand *Chitra indica* is dealt with in a similar manner.

Key to the Indian species of Trionyx.

1. Two neural plates between the first pair of costals.
   - (A) A strong longitudinal ridge on the mandibular symphysis; coloration of adult very dark......... *T. nigricans.*
   - (B) The longitudinal ridge on the mandibular symphysis feebly developed or absent.
     - a. Mandibular symphysis produced in front, its length being much greater than that of the orbit: at least four large and conspicuous ocelli as well as a dark reticulation on the disk of the young, that of the adult dark.............. ....*T. hurum.*
     - a^1. Mandibular symphysis not much longer than the orbit.
       - *a.* Disk pale, with radiating dark lines but no ocelli in the young; inner margin of mandible ridged........................*T. gangeticus.*

a'. Disk of young with four ocelli; inner margin of mandible without a ridge........*T. leithii.*

II. A single neural plate between the first pair of costals: a strong longitudinal ridge on the mandibular symphysis.

A. Epiplastra widely separated immediately in front of the entoplastra....... .... *T. formosus.*

B. Epiplastra in contact in front of the entoplastra.

a. Plastral callosities feebly developed, finely sculptured.............................*T. phayrei.*

a[1]. Plastral callosities well developed, deeply sculptured................ ....*T. cartilagineus.*

The above key is based on the one given by Mr. Boulenger on pp. 10 and 11 of his volume in the "Fauna," but has been modified to include the species omitted by him.

A table of measurements of the skulls of this genus and of *Dogania* preserved in the Indian Museum is given at the end of this paper.

2. **Trionyx gangeticus**, Cuvier (pl. v, figs. 1, 1a, 2).

Boulenger. Fauna, p. 12: Siebenrock. p. 596.

DISTRIBUTION.—The Indus, the Ganges, the Mahanaddi and their tributaries; probably also the Brahmaputra system. Mr. Boulenger is wrong in suggesting that this species does not occur in the Indus, for specimens from Karachi are identical, at any rate so far as head-markings and skull-characters are concerned, with those from Lower Bengal. The species, although not so abundant in the Calcutta market as *T. hurum*, is sold for food in considerable numbers, being brought from different places in the Gangetic delta, especially from Khulna.

SPECIMENS:

BENGAL.

1805 (no skull)	Calcutta.	*Purchased.*
1808 ,,	,,	,,
1806 (skl.)	,,	
1080-3: 1089 (skulls)	,,	
78-9 (skull)	,,	
3870 (skulls)	,,	
1720-2 (stuffed)	,,	
1724 ,,	,,	,,
1716 ,,	,,	,,
1893 (carapace & skull)	,,	*Dr. J. Anderson.*
1895 (skl.)	,,	,,
1052-3 (skulls)	Ganges.	,,
1054 ,,	,,	?
288 (spirit)	Hughli.	?
879 (32 b. A. S. B.)	Calcutta.	*E. Blyth, Esq.*
881 (32 d. A. S. B.): juv.	,,	,,

881 (32 d. A. S. B.): juv.	Calcutta.	*E. Blyth, Esq.*
882 (32 e. A. S. B.) ,,	,,	,,
883 (32 f. A. S. B.) ,,	,,	,,
884 (32 g. A. S. B.) ,,	,,	,,
1084-6 (skulls)	,,	,,
16750-1 (skl.)	Probably from Khulna Dist.	*Dr. N. Annandale & B. L. Chaudhuri, Esq.*

UNITED PROVINCES.

1810 (carapace): juv.	Allahabad.	*E. Atkinson, Esq.*
1729 (stuffed)	,,	*J. Cockburn. Esq.*
468 (spirit)	,,	,,
285 (,,)	,,	,,
286 (head in spirit)	,,	,,
756 (skull)	,,	,,
1732 (stuffed)	Agra ?	*Dr. Stoliczka.*
1727 ,,	Agra.	,,
1728 ,,	,,	*Riddell Museum. Agra.*

SIND.

1835-6 (skulls)	R. Indus, Karachi.	*Karachi Museum.*
3869, 3871-2 (heads in spirit)	,,	,,

Very old individuals lose the characteristic markings to a greater or less extent, sometimes becoming of an almost uniform pale olive-green all over the dorsal surface of the head and body. The ventral surface is never dark. The iris varies in colour from emerald-green to golden yellow.

The bony carapace of the largest specimen I have seen measures 48·5 cm. in length by 53·4 cm. in breadth. So far as I am aware, there are always two neural plates between the first pair of costals. The presence or absence of a callosity on the entoplastron is not correlated, either in this species or in *T. nigricans*, with age or sex. In some small individuals it is present, while in other much larger and evidently older ones no trace of it can be found. The median projection of the hyoplastra,[1] except in very young individuals, is double and comparatively short and stout, disappearing altogether in very large specimens, in which the two hyoplastra are in contact or almost in contact in the middle line for the greater part of their length. The sculpture on the sternal callosities is very deep and strong. The skull becomes much broader and blunter with age. The hypobranchials (fig. 1) are long and comparatively slender. In old individuals they are followed at the distal end by four or five short flattened oval bones, but in the young these are represented by cartilage.

[1] Cf. Siebenrock, S. B. K. Akad., Wiss. Wien, CXI, p. 280, fig. 3.

3. Trionyx leithii, Gray.

T. leithii, Gray, P. Z. S. 1873, p. 49, fig. 3. *T. gangeticus*, *id.*, *ibid.*, pl. viii.

Boulenger, Fauna, p. 12. Siebenrock, p. 597.

DISTRIBUTION.—The limits of distribution of this form are very imperfectly known. It was described from Poona in the Western Ghats and was taken by the late Colonel Beddome in the Nelambar River, which is also in the Malabar zone. Mr. Boulenger states that the species occurs in the Kistna River and that the figure of it reproduced by Gray in 1873 as representing *T. gangeticus* was a copy of a drawing of specimens from Fatteghar.[1] The late Dr. W. T. Blanford obtained specimens in the Upper Mahanaddi system and in the lower reaches of the Godavari.

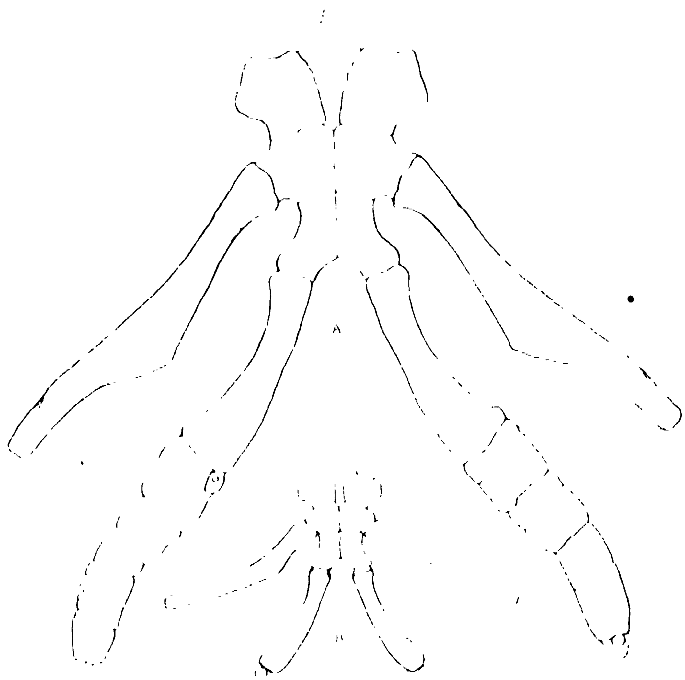


FIG. 1.—Branchial Skeleton of *Trionyx gangeticus*, × $\frac{1}{3}$.
A, of adult; B, of young.

SPECIMENS:—

16503 (spirit): juv. ? ?

[1] There are two places of this name in N.-W. India, one on the R. Ganges, the other in Patiala State and within the limits of the Indus system.

1731 (stuffed: skull separate): juv.	Hasdo R. (tributary of the Mahanaddi), Bilaspur district, Central Provinces.	.. *Dr. W. T. Blanford.*
522 (spirit: skull separate): juv.	Godavari valley.	

The only specimens in our collection that can be assigned to this species are young individuals. A figure of the plastron of the largest is reproduced below (fig. 2).

FIG. 2.—Plastron of *Trionyx leithii* (young), × ½.

4. Trionyx hurum, Gray (pl. v, fig. 3).

Boulenger, Fauna, p. 13, fig. 5 (young): Siebenrock, p. 597.

DISTRIBUTION.—The lower reaches of the Ganges; the Brahmaputra as far north and east at the point at which it debouches on the plains. The species is said to occur also in Indo-China,[1] and in the Malay Peninsula,[2] but the latter locality rests on insufficient evidence. Although *T. gangeticus* makes its way as far north as the base of the Nepal foot-hills and as far west as Karachi, I have been unable to obtain any evidence that *T. hurum* is found much above Rajmahal. Moreover the only specimen (No. 10627) I have seen that was actually taken in Bengal outside

[1] Mocquard, "Les Reptiles de l'Indo-China" (*La Revue coloniale*, 1907, p. 13).

[2] See Flower, P. Z. S. 1899, p. 601, and 1899, p. 620.

the Gangetic delta was so peculiar in coloration that it may well represent a distinct local race. Specimens from Assam are perfectly typical in coloration. I have seen a consignment of over 500 individuals from Khulna being unloaded at the railway station. The "fishery" takes place mainly in October.

SPECIMENS :—

	BENGAL.	
1050 (skull)	Calcutta.	*Dr. J. Anderson.*
1920 (skl.)	,,	,,
1797 (skl. deformed)	,,	,,
1049 (skl.)	Ganges.	,,
1047 (skull)	Calcutta.	*Purchased.*
270 (skl.) : juv.	,,	,,
1796 (skl.)	,,	,,
1784 (stuffed)	,,	,,
6846 (spirit) : juv.	,,	,,
271-2 ,,	,,	,,
1090 (Skl.) Type of *T. buchanani*, Theob.	,,	,,
16752 (skl.)	Gangetic delta.	*Dr. N. Annandale.*
292 (spirit) : juv.	R. Hughli.	*Purchased.*
287; 289-91 (spirit) : juv.	,,	?
273-4; 276 (spirit) : juv.	Calcutta.	*Dr. W. Theobald.*
16627 (Skl.)	Oodhua *nallah*, R. Ganges, near Rajmahal.	*B.L. Chaudhuri, Esq.*
283; 660 (spirit)	Kaligunge.	*W. Dodgson, Esq.*
16505 (head in spirit)	Dacca, E. Bengal.	*H. E. Stapleton, Esq.*
5578 (spirit)	Nattore, Rajshahi Dist., E. Bengal	*T. R. Doucett, Esq.*
	ASSAM.	
659 ,,	Nazir, N. of the Naga Hills, E. Assam.	*J. M. Foster, Esq.*
303 ,,	,,	,,
402-4 ,,	Sibsagar.	*S. E. Peal, Esq.*
11373 ,,	Dilcoosh, N. E. Assam.	*J. Ingles, Esq.*

In this species the coloration of the dorsal surface normally grows darker and more obscure with age, although the ventral surface is dark in the young and only assumes its uniform pale colour in half-grown individuals. Buchanan (Hamilton) in his collection of drawings now preserved in the Asiatic Society of Bengal's library figured three stages as distinct species. The first of these drawings (No. 52) is labelled *Testudo ocellata* and represents the young in which four large ocelli and a bold reticulation of black lines are conspicuous on the dorsal surface of the

disk. The second (No. 54), which is labelled *Testudo hurum*, represents an older individual in which the ocelli have become obsolescent, the ring of bright reddish yellow which surrounds the central dark spot having faded and the spot itself having increased greatly in size, while the reticulate lines have multiplied and become more vermicular in character. The third drawing (No 53) evidently represents a much larger specimen; it is labelled *Testudo chhim*. The whole of the dorsal surface of the disk has darkened and only small and somewhat obscure yellowish spots represent the pale ground-colour of the juvenile disk. The ventral surface is represented as dark olive faintly speckled with a pale shade in the first figure and uniformly pale in the others. The coloration of the head varies somewhat in the adult as regards the relative proportions of the yellow and the dark green areas. The former colour usually predominates on the snout and on the sides of the head behind the mouth and the latter on the post- and inter-orbital regions, forming a more or less close and dense reticulation. In the young the two colours are more definitely separated. In old individuals traces of dark radiating lines can sometimes be detected on the edge of the disk, while that of the young is usually spotted minutely with yellow. The iris is greyish.

The specimen from near Rajmahal to which allusion has already been made was altogether abnormal in coloration. It was a half-grown individual with a disk measuring 27·6 cm. in length. The whole of the dorsal surface was of an almost uniform pale olive, green on the head and neck and greyer on the limbs than on the disk, which showed no trace of ocelli markings of which traces can usually be detected in even larger individuals. The disk, however had an obscure mid-dorsal stripe crossed by five cross-bars, all of a slightly darker shade than the ground-colour. The posterior part of the upper surface and sides of the head was obscurely clouded with dark olive. The whole of the ventral surface was pale and the iris was pinkish white. Fortunately a record of the colours of this specimen, which is preserved as a skeleton was kept in the form of rough water-colour sketches and a cast of the fresh specimen was made and painted accordingly.

The snout does not become much blunter or the head broader with age in this species. In some very old individuals, however, the nasal aperture is, on the skull, considerably broader than the inter-orbital space, but this appears to be due, judging from the rugosity of the bones, either to senility or to disease. The hypobranchials (fig. 3) are comparatively short and broad; even in aged individuals they bear at the distal end only a cartilaginous plate containing a small ossicle.

The size reached by this species is not so great as that commonly attained by *T. gangeticus*. The largest individual I have seen was a male recently purchased in Calcutta and said to have come from Khulna. Its dorsal disk measured 60·0 × 40·9 cm. and its bony carapace 51·6 × 40·9 cm., the disk being rather narrower than usual

Specimen No. 1094, an articulated male skeleton, is the type of Theobald's pseudo-species *T. buchanani*. It presents a very large male only slightly smaller than the one to which I have just referred, the bony carapace measuring 38·4 mm. in length and being distinctly broader than long.

The structure of the carapace and sternum of *T. hurum* is closely similar to that found in *T. gangeticus* except that the two

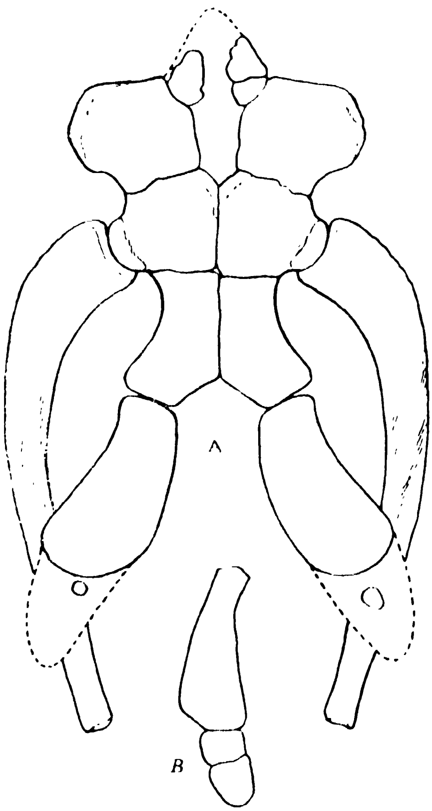


FIG 3.—Branchial skeleton of *Trionyx hurum* and *T. formosus*.
A, complete apparatus (nat. size) of adult *T. hurum*.
B, hypobranchial, etc. of *T. formosus* (nat. size).

hyoplastra approach one another at a rather earlier stage and that their median processes are slighter and always single although distinctly bifid at the tip

A not uncommon abnormality, noticed in both young and old individuals, is the presence of three neural plates between the first pair of costals. This is due to the separation of a small bone, sometimes quite symmetrically, from the central part of the anterior border of the first normal neural plate.

5. Trionyx nigricans, Anderson (pl. v, fig. 5).

Anderson, Ann. Mag. Nat. Hist., (4), XVI, p. 284 (1875).

The first pair of costals are separated by two neural plates. The posterior paired bones of the plastron are provided with well-developed callosities on which the sculpturing is only a little less strong than in *T. gangeticus*, and in some individuals there is also a callosity on the entoplastron. The hyoplastra do not meet in the middle line and are strongly divergent posteriorly, although they are relatively larger than in *T. phayrei*; their median process is single, short, stout and blunt, indistinctly bifid at the tip. The epiplastra are narrowerly separated or actually in contact in front of the entoplastron.

The skull is moderately broad, the snout a little longer than the diameter of the orbit; the interorbital width is greater than that of the nasal fossa and the postorbital arch is about one-third as wide as the orbit; the zygomatic arch is horizontal, less distinctly curved than in *T. phayrei*.

The alveolar surface of the upper jaw bears low median and internal longitudinal ridges. The lower jaw has a strong longitudinal ridge on the symphysis, which is a little longer than the orbit; there is no internal alveolar ridge.

Anderson describes the external characters as follows:—

"Carapace rather flattened on the back, with the vertebral groove ill-defined anteriorly, but well marked posteriorly. Nuchal swelling broader than in *T. gangeticus*, but not prominent, the carapace on either side being flattened. Alae of plastron well defined, projecting equally beyond the carapace. Nuchal flap narrow, and covered with rather large nodose folds; and the hinder portion of the cartilaginous margin of the carapace with little nodosities. The rugosities of the osseous carapace coarser than in *T. gangeticus*.

The under surface of the thighs and tail and of all the soft parts, including the head and neck, covered with little papillae. No trace of rugosities on the axygos plate of the plastron visible through the skin

The tail in the female does not reach to the margin of the cartilaginous portion of the carapace.

Colour of the carapace dark blackish plumbeous, with a tinge of olive due to the presence of blackish spots, among which are inter-mixed many rusty brown spots, which overlie as it were the black spots. The head, neck, and upper surface of the limbs are almost black; the upper lip in its two posterior thirds is white; and there is a great white blotch over the ear.

The area between the neck and the four legs is whitish; and there are some white spots on the margin of the carapace. The head is reticulately spotted; and there is a distinct infrapraeorbital band, and a trace of another above the eyes; but the head is so black that these markings are difficult to distinguish. The under surface of the head and neck is almost black; and the

plastron is densely spotted with blackish purple, especially over the bones, and the tail is similarly marked. The claws are yellow."

DISTRIBUTION.—With one exception the specimens of this species are labelled as being from Chittagong in the extreme south-eastern corner of the old Province of Bengal. The one exception is labelled as being from Calcutta, but this locality is probably incorrect and in view of the fact that large numbers of Trionychids are imported into this city for food, carries in any case very little weight unless supported by independent evidence. It should therefore be ignored, unless it can be substantiated by the capture of specimens in the Gangetic delta, the probability being that *T. nigricans* is a species intermediate in habitat, as it is in structure, between *T. gangeticus* and *T. phayrei*.

SPECIMENS:—

BENGAL.

1918 (skl.)	.. Chittagong Tanks	..	*A. L. Clay, Esq.*
754 (skl.)	.. ,, ,,	..	,,
1908 (skl.)	.. ,, ,,	..	,,
1898 (skl.) } Types.			
735 (skl. no skull) }	.. ,, ,,	..	,,
1849 (skl.)	.. "Calcutta"	..	*Dr. J. Anderson.*

T. nigricans may be stated in general terms to resemble *T. phayrei* in the structure of its skull and mandible and *T. gangeticus* in that of its carapace and plastron. In coloration, however, it evidently differs from both and neither its skull nor its plastron agrees precisely with that of the species which they respectively recall. All the specimens appear to be adult and both sexes are, to judge from Anderson's labels, represented. The bony carapace of the largest measures 40·3 cm. in length by 46·7 cm. in breadth.

6. Trionyx phayrei, Theobald (pl. v, fig. 4).

Anderson, P.Z.S. 1871, p. 154, fig. (plastron): Boulenger, Fauna, p. 14: Flower, P.Z.S. 1899, p. 620: Siebenrock, p. 598.

DISTRIBUTION.—Arrakan, Pegu, Tenasserim, the Malay Peninsula, Sumatra, Java (*Max Weber*) and Borneo. In Arrakan this species occurs in mountain streams and Flower states that he found a specimen in a similar situation in Johore. As Mr. H. C. Robinson has pointed out to me, the locality "Penang" must be accepted with caution, for there is a Chinese temple on the island in which tortoises from many different parts of the Malay Archipelago are kept.

SPECIMENS:—

755 (skull and plastron)	.. "Penang"	.. *Dr. J. Anderson.*
1094 (stuffed: skull separate)	.. Arrakan	.. (*Purchased*).

Both these specimens present fully adult individuals and have already been referred to in published works. No. 1094 is the one mentioned by Theobald on p. 15 of his "Catalogue of Reptiles in the Museum of the Asiatic Society of Bengal" as *T. guntherii*, Gray; while the other (No. 755) is all that remains of the specimen described in detail by Anderson in 1871.

I was at first inclined to think that neither could belong to the species described by Theobald as *T. phayrei*, because of the broadness of the skulls (fig. 4) and of the fact that the callosities

FIG. 4. Adult skull of *Trionyx phayrei* from below (reduced).

of the plastron are distinctly though not deeply sculptured. It is, however, probable that these discrepancies are due entirely to the fact that most of the specimens hitherto examined have not been fully adult, for parallel if not quite as great differences may be noticed between the skulls of half-grown and of full-grown individuals of *T. gangeticus* as those that evidently exist between the skull figured by Gray under the name *T. jeudi* (and by Boulenger in his British Museum Catalogue (p. 252, fig. 6) under that of *T. phayrei*) and those now before me. It is evident, moreover

that Anderson in describing and figuring the plastron of his specimen did not remove the outer integument, which still adheres to the bone, and that in consequence he believed the surface to be smoother than actually was the case. As a matter of fact it is more nearly smooth than that of any Indian species, although by no means devoid of sculpturing.

The bony carapace of specimen No. 1094 measures 40·3 cm. by 50·6 cm.; that of No. 755 was, according to Anderson, slightly smaller. The median processes of the hyoplastra in this species are single, slender and pointed. They are never bifid at the tip.

T. phayrei is connected with *T. gangeticus* through *T. nigricans*, from which it differs chiefly in having only one neural plate between the first pair of costals. The skull is also broader than that of *T. nigricans*, in fully adult individuals.

7. Trionyx formosus, Gray (pl. v, fig. 6).

Boulenger, Fauna, p. 14: Siebenrock, p. 598.

DISTRIBUTION.—The Irrawaddi, Sittang and Salween Rivers. In the Irrawaddi this species is found near the Chinese frontier, as well as in the lower reaches. Numerous individuals, many of which are deformed, are kept in a small pond at the Arrakan Pagoda in Mandalay. I take it they belong to this species. It is very possible that statements regarding the occurrrence of *T. hurum* in the Malay Peninsula actually refer to *T. formosus*, but the latter species has not been definitely recorded from any Malay locality.

SPECIMENS:—

	BURMA.	
1786 (skl.)	.. Moulmein	.. *Maj. Sladen.*
277-8 (spirit)	.. Mandalay	.. ,,
634 (skull)	.. Bhamo	.. *Maj. Lowndes.*
1837 (skl. juv.)	.. Burma	.. *Dr. J. Anderson.*
1063 (skull)	.. ,,	.. *Hon. A. Eden.*
605 (skl.)	.. ,,	.. *Maj. Sladen.*
685 (skl.)	.. Irrawaddi	.. *Maj. Lowndes.*
687 (spirit)	.. ,,	.. *Hon. A. Eden.*
1051 (carapace and palastron)	.. ,,	.. *Dr. F. Stoliczka.*
766 (skl.)	.. Burma	.. *Hon. A. Eden.*

This appears to be a comparatively small species. The bony carapace of the largest specimen in the collection measures only 27·4 × 26·5 cm.; its skull appears to be fully adult. In this specimen there are actually two neural bones between the first pair of costals, but the suture is asymetrical and there can be no doubt that the condition is abnormal. In most cases the median process of the hyoplastra is short, single and rather stout, its

apex being bluntly pointed. In one skeleton, however, the right process is double.

The branchial skeletion (fig. 3, p. 163) resembles that of *T. hurum*, but the distal bones of the posterior process are more fully ossified, the hypobranchial being followed by two distinct bony plates of moderate size.

8. Trionyx cartilagineus (Boddaert).

Boulenger, Fauna, p. 15: Siebenrock, p. 599.

DISTRIBUTION.—Pegu, Tenasserim, Siam, Cambodia, the Malay Peninsula, Sumatra, Java, Borneo. This is evidently a Malayan species which has made its way into Lower Burma. It appears to be scarce in Pegu and Tenasserim but to be the common species of the Malay Peninsula.

SPECIMENS :—

BURMA.

2632 (spirit : skull separate) : juv. .. R. Irrawaddi .. *Dr. W. Theobald.*

MALAY PENINSULA.

13207 (spirit) : juv. .. Perak .. *Dr. J. Anderson.*

Both of the above specimens are very young. Their skulls, which I have had removed, show the specific characters quite clearly.

Genus PELOCHELYS, Gray (1864).

Boulenger, Fauna, p. 15: Siebenrock, p. 606.

This genus is closely allied to *Chitra* but may be readily distinguished therefrom by the large and prominent orbits, which occupy a less anterior position on the skull. The plastron and carapace are very similar in the two genera. *Pelochelys* is another monotypic genus but has a much wider range, so far as we know, than *Chitra*.

9. Pelochelys cantorii, Gray.

DISTRIBUTION The lower reaches of the Ganges, (?) Assam, Burma, Indo-China, Siam, the Malay Peninsula, Borneo, the Philippines and New Guinea. *P. cantorii* appears to be a scarce species in all the localities in which it is found. I have not seen a single fresh specimen, and the two old ones in our collection are probably immature.

SPECIMENS :—

BENGAL.

1781 (skl.) .. R. Hughli, Calcutta .. *Dr. J. Anderson.*
886 (33 a. A.S.B.) .. ,, ,, .. ?

Genus CHITRA, Gray (1844).

Boulenger, Fauna, p. 16: Siebenrock, p. 608.

This genus, of which only one species is known, is easily recognized by the elongate appearance of the skull, the eyes being situated close to the snout, and the complex form and unusually complete ossification of the branchial skeleton. The plastron[1] and carapace do not differ materially from those of *Trionyx*. The photographs reproduced on plate vi show clearly the general structure and proportions of the branchial skeleton, although its position relative to the skull is perhaps a little distorted. The basal part consists of four pairs of bones either sutured in the middle line or narrowly separated. Those of the most anterior pair (fig. 2, 1) are in close contact with one another for the greater part of their length as well as being firmly sutured to the next pair. They are roughly triangular in shape and probably represent the basihyal element, although they are not produced into horns at the sides. Behind them follow three other pairs of bones which may be taken to be the basibranchial; those of the first pair are smaller than those of the two posterior pairs and remain separated in the middle line even in old individuals. Those of the next pair are transverse in shape and form a median suture; they support the greater cornua, which are articulated to their sides. These bones are comparatively stout and long and are not expanded dorso-ventrally; they bear very large and well-developed muscular impressions near the proximal end of their external margin. The posterior processes are of great size and considerably expanded in the lateral plane, their ossification being unusually complete. Each consists of three broad bones fitted together by serrated sutures. The first of these is much the longest of the three and probably represents the hypobranchial and ceratobranchial fused together. In this case the second bone would be the epibranchial and the third the pterygobranchial. The former is a short plate of bone, the latter, although no broader at its outer margin, is bluntly produced towards the ventral margin in such a way that it is more than twice as broad within as it is without. The whole process curves inwards and upwards towards its fellow. In the large specimen mentioned below the length of the bony hyoid apparatus is nearly as great as the skull; the basal part measures 9 cm., each horn 11 cm., and each posterior process 13 cm. in length.

10. Chitra indica (Gray) (pl. vi, figs. 1, 2).

DISTRIBUTION.—The Ganges and Irrawaddi river-systems, as far as the base of the Himalayas in the former. The species is not uncommon in the Gangetic delta and large individuals can often be bought in the Calcutta market, in which, however, they are less abundant than *T. hurum* and *T. gangeticus*.

[1] Siebenrock, S.B.K. Akad. Wiss. Wien, CXI (1), p. 833, fig. 12, 1902.

SPECIMENS:—

BENGAL.

1776; 1113 (skl.) ..	Calcutta. ..	*Purchased (Dr. J. Anderson.)*
3543 ,, .	Zoological Gardens, Calcutta.	*Peer Bux.*
1046 (skull) ..	R. Hughli, Calcutta	?
1055 ,, ..	Dacca, E. Bengal ..	*Dr. Wise.*
16753 (skl.) ..	Probably from Khulna	*B. L. Chaudhuri, Esq.*

UNITED PROVINCES.

483 (spirit): juv...	Allahabad ..	*J. Cockburn, Esq.*

Chitra indica is apparently the largest of the Indian Trionychids. The bony carapace of the largest specimen examined measures 52·3 cm. × 59·7 cm. The length of its skull (pl. vi, figs 1, 2) measured from the tip of the snout to that of the articular condyle is 17·8 cm., and the greatest breadth 10 cm. The carapace may be distinguished from any purely Indian species of *Trionyx* by possessing only one neural bone between the first pair of costals. The epiplastra are more widely separated from one another than in *T. hurum* and *T. gangeticus* and the anterior part of each is shorter than in most species of *Trionyx*. There are three or four processes on the inner margin of each hyoplastron.[1]

Genus EMYDA, Gray (1831).

Boulenger, Fauna, p. 49: Siebenrock, p. 590.

A consideration of this genus, which probably occurs only in the Indian Empire and in Ceylon, raises questions of considerable taxonomic and geographical interest. As a genus it is easily distinguished from all other Trionychids of the Oriental Region by the fact that the hind limbs are protected by cartilaginous flaps or valves which can be closed over them on the ventral surface. Mr. Boulenger recognizes three species in the "Fauna," but expresses a doubt as to whether two of them are really distinct. After examining a large series of skeletons and specimens in spirit and seeing living individuals in different parts of India, I find it possible to recognize only one species with several local races or subspecies.

The branchial skeleton resembles that of *Trionyx* but differs in having the basihyals in close contact, the lateral margin of each basihyal produced into a blunt horn, the posterior margin of the posterior basibranchials deeply emarginate and the hypobranchials (with which the ceratobranchials are perhaps fused) very long and slender.

[1] Siebenrock, S.B.K. Akad Wiss. Wien, CXI (1), p. 845, fig. 18, 1902.

The peculiar structure of the carapace and plastron of this genus, in which the soft parts can be more completely protected than in any other Indian genus of the family, may perhaps be correlated with a peculiarity in habits. *Trionyx* usually inhabits rivers and appears to be active at all times of the year, but *Emyda* lives in ponds and lakes and undergoes, at any rate in northern India, a considerable period of hibernation. Specimens were brought me in February at Purulia which had been dug from the mud in the basin of a dried pond, while the individuals which inhabit the Museum tank in Calcutta disappear for the whole of the cold weather. Not only can the characteristic cartilaginous flaps of the plastron close tightly over the hind limbs, but the anterior part of the carapace is flexible, owing partly to the fact that the nuchal plate is not as a rule united to the first pair of costals; it can be bent down to meet the anterior margin of the plastron in such a way that the retracted head and fore limbs are completely concealed, while the posterior part of the disk, including the marginal bones, can be bent down in a similar manner to protect the thighs and tail.

The typical form of *E. granosa*, although it rarely leaves the ponds in which it lives, is fond of sunning itself on logs or stones projecting above the surface of the water. It is extremely timid and difficult to approach. I have taken a young specimen of the South Indian form (*vittata*) at the edge of a pond among weeds.

11. Emyda granosa (Schoepff).

The distribution of this species cannot be considered apart from the question of the characters whereby its local races are separated. So far as it is possible to judge from the collection before me, three local races occur in India, one in Burma and one in Ceylon. They are:—

(1) Indian races: —*E. granosa* (typical form), subspecies *intermedia*, nov., and subspecies *vittata*, Peters.

(2) Burmese race:– Subspecies *scutata*, Peters.

(3) Ceylon race:—Subspecies *ceylonensis*, Gray.

(1) The *forma typica* is confined in India proper to the valleys of the Indus and Ganges, but it probably occurs in Assam and certainly does so on the coast of Arrakan.

The subspecies *intermedia* occurs in the valleys of the Barakar and Kasai rivers, which reach the sea, just south of the Ganges, through the Hughli estuary, and in those of the Mahanaddi and the Godavari. Politically its range extends through Chota Nagpur, the Central Provinces, Orissa and the north-eastern part of the Presidency of Madras.

The subspecies *vittata*[1] is found in the Madras Presidency, over the greater part of which it ranges, occurring on the Mysore

[1] Siebenrock (p. 591, footnote) states that the Vienna Museum possesses a specimen of this race which appears to have come from Celebes, but the evidence as regards its provenance is not satisfactory.

plateau at an altitude of at least 3,000 ft. and also at sea level on the coast. It also occupies the greater part of the Bombay Presidency, including Cutch.

(2) The Burmese race (*scutata*) is only known from the valleys of the Irrawaddi and the Salween.

(3) The Ceylon race (*ceylonensis*) is confined to the plains of that island.

A. *Forma typica.* The granulations on the carapace and more especially on the plastral callosities are small, even and regular and are not arranged in concentric curves. The head and the carapace, at all ages, are of a dark olivaceous shade conspicuously spotted with yellow. There are usually 14 bony marginal plates situated round the posterior part of the carapace. The entoplastral callosity is never very large and the xyphoplastral callosities are never in contact for the whole of their length, invariably diverging from one another above. The median process of the hyoplastra is long and slender.

B. *intermedia* (pl vi, fig. 3). The granulations of the plastral callosities are coarser and more irregular, the granules being larger but not arranged definitely in concentric curves. The head of the young is very obscurely marked: the carapace is deep olive-green with obscure paler markings The head of the adult bears very conspicuous longitudinal dark lines; its carapace is dark olive-green with a darker vermicular reticulation. The entoplastral callosity is of moderate size and the two xyphoplastral callosities are never in contact for the whole of their length. The marginal and the median hyoplastral process are as in the preceding race.

C. *scutata.* The granulations of the plastral callosities are still coarser than in *intermedia* and the granules tend to be arranged in concentric curves. The head of the young bears longitudinal dark lines, but the carapace is without markings at any age. In older individuals the dark lines on the head tend to disappear, the colour being an almost uniform

dark brown. In other characters this race resembles *intermedia*.

D. *scutata*. The granulations of the plastral callosities resemble that of the *forma typica* but the pale markings on the head and carapace are completely absent. In the young the carapace bears obscure dark spots, which tend to form a reticulation in the adult. The entoplastral callosity is very large. The marginal bones never fuse together; all are small and there are usually 18 present. The median hyoplastral process is very short and the xyphoplastral callosities are often in contact for their whole length

E. *ceylonensis*. This race is closely allied to *vittata*, from which it is distinguished by the great relative size of the entoplastral callosity, by the facts that the xyphoplastral callosities are in contact for their whole length and that the marginal bones show a greater tendency towards fusion (only 12 being usually present), and by the extreme shortness in the adult of the median xyphoplastral process. The carapace of the young is obscurely spotted with a dark shade and there are black longitudinal lines on the head. The adult as a rule appears to be devoid of definite markings.

The only differences between these races lie in coloration, in the sculpturing of the plastral callosities, in the degree of ossification attained by the plastron, and in the number of posterior marginal bones that normally fuse together in the adult. Except coloration and plastral sculpturing none of these differences can be called constant, and even in coloration and sculpturing a certain amount of variation occurs. It may therefore be well to discuss each character separately.

To deal with coloration first: I should state that while I have seen a considerable number of living individuals of the typical form of the species and of the races *intermedia* and *vittata*, I have only been able to make a detailed examination of fresh material in the case of the two former and have not seen living individuals of either the Burmese or the Ceylon race. Specimens preserved in spirit, however, even for many years, as a rule show at least traces of the characteristic markings, except that the dorsal reticulation of the race *intermedia* disappears completely.

Moreover, Dr. J. R. Henderson has been kind enough to send me notes on the natural colours of the Madras race (*vittata*) at different stages. These notes confirm observations made on specimens preserved in spirit.

The spots on the dorsal disk of the Indo-Gangetic race are variable in size, number and arrangement but are perfectly distinct even in the largest individuals. Sometimes the larger spots have dark centres and resemble irregular ocelli. The markings on the head are much more regular. A large pale spot covers the greater part of the snout and of the interorbital region, being interrupted in the latter by a circular or nearly circular dark spot. There are two smaller pale spots beneath each eye and another above the angle of the mouth. A broad pale stripe runs obliquely backwards from below the eye towards the tympanic region and two longitudinally oval spots, sometimes united to form a V-shaped mark, form an angle above it, the anterior spot starting from the posterior upper border of the orbit. Sometimes the oblique stripe is broken up into two or more spots. There are also two or three smaller pale spots on each side of the back of the head. So far as can be judged from specimens preserved in spirit, those from Calcutta agree closely with those from Akyab on the one hand and Karachi on the other.

The pale spots on the back of the young of the race *intermedia* are very obscure and could not be recognized except in fresh specimens. The dark reticulation on the back of the adult is much more distinct but fades gradually in spirit The dark lines on the head are, however, much more persistent. They are also conspicuous on small specimens of the Ceylon race (*ceylonensis*) that have been in spirit for many years.

The races of *Emyda granosa* fall into two groups as regards the sculpturing on the plastral callosities ; in one group (consisting of the typical form, *intermedia* and *scutata*) the granules are much more regular, more uniform in size and more widely distributed on the surface of the bone than they are in the other, in which they tend to run together and to be arranged in concentric curved lines. The second group consists of *vittata* and *ceylonensis*. This difference is best observed in young individuals. The size of the entoplastral callosity is correlated to some extent with the degree of ossification attained by the other bones of the plastron. When the callosity is very large the xyphoplastra are always in close contact for the whole of their length on the inner margin. These characters, however, vary greatly in all races and it is only by examining *fully adult* individuals that satisfactory results can be obtained.

The following measurements, all of which are taken from the skeletons of adult females, show at any rate the large size of the entoplastral callosity in the adult of the Ceylon race. There is, however, considerable variation in the size of this callosity in specimens from India, although it is never nearly so large as it is in the race *ceylonensis*.

	Calcutta.	*Madras.*	*Ceylon.*
Length of carapace	22·8 cm.	22·5 cm.	24·5 cm.
Breadth ,, ...	21·0 ,,	20·4 ,,	19·0 ,,
Length of entoplastral callosity ..	2·2 ,,	2·5 ,,	5·0 ,,
Breadth ,, ,, ..	2·5 ,,	1·7 ,,	5·5 ,,
Length of xyphoplastral callosity	5·3 ,,	5·0 ,,	5·7 ,,
Breadth ,, ,, ..	3·3 ,,	3·5 ,,	3·5 ,,

In measuring the carapace the length of the marginals is omitted and the longest measurement of the callosities that can be obtained in a straight line is given.

The relative size of the anterior marginals is due in the first instance to the fusion or non-fusion of several bones. The full number of marginals appears to be eighteen, nine on either side. In all the Indian races, and also in the Ceylon race, several of the most anterior of these bones normally fuse to form a single plate, the fusion taking place at a comparatively early age. Many irregularities, however, occur and it is often the case that the number of bones which have fused on one side is not the same as that of those which have fused on the other. Moreover, the pattern of the granules on the ventral surface often shows the line in which fusion has occurred, even in old individuals. Especially in the Ceylon race, moreover, the bone fused by the fusion of the first three marginals tends to increase greatly in width as the animal grows old. In the Burmese race (*scutata*) no such fusion normally occurs, but it is noteworthy that in a half grown individual from Akyab which exhibits all the other characters of the typical *granosa* the marginals remain separate as in *scutata*, although in a slightly larger individual from the same locality the first three bones on either side are completely fused.

Emyda granosa (Schoepff).

BENGAL.

875-7 (stuffed): 13470-1 (carapace) 1714: 1772 (skl.) 1027-32 (plastra)	Calcutta and neighbourhood.	*Purchased; Dr. J. Anderson; E. Blyth, Esq.; Medical College.*
242-3, 226-8, 239, 13380, 213-6, 218, 233-5, 237-8, 220, 4229-32, 370-1, 16501, 240-1 (spirit)	Ditto	*Purchased; Dr. J. Anderson; E. Blyth, Esq.; W. Theobald, Esq.; O. L. Fraser, Esq.; Dr. J. T. Jenkins; C. Swaries, Esq.; D. Cunningham, Esq.*
1034-42 (skulls)	Calcutta or N. W. Provinces	?
1824 (skull)	Jessore	*C. Tweedie, Esq.*
1023 (skl.)	Sunderbunds	*O. L. Fraser, Esq.*

SIND.

3878-80 (spirit)	R. Indus, Karachi	*Karachi Museum Ex.*
3377 ,,	Jempir	,, ,, ,,

BURMA.

244-5 (spirit)	Akyab	*Deputy Commissioner, Akyab.*
12627-9 ,, : juv.	Jergo I., Off Arrakan Coast.	*Indian Marine Survey.*

Emyda granosa intermedia, Annandale.

CHOTA NAGPUR AND ORISSA.

1663, 1665, 1669-71, 1673-5, 1677-80, 1688, 1686, 1689, 1694 (skl.)	Hazaribagh.	*Lt.-Col. Boddam.*
250 (spirit)	,,	,, ,,
1662, 1664, 1666-7, 1672, 1676, 1681-2, 1692-3 1685 (skl.)	Chota Nagpur	*Col. Dalton.*
1733-41 (plastra)	,,	,,
1024, 1683 (skl.)	Singhboom	*H. Hayes, Esq.; Lt. Col. Boddam.*
257-61, 294 (spirit)	,,	*H. Hayes, Esq.*
246 (spirit)	Surjuga	*Dr. V. Ball.*
251-3 ,,	Ranchi	*Col. Dalton.*
16694 (skl.)	Chaibassa.	*Rev. A. Logsdail.*
405-7 (spirit)	Sambalpur.	*Dr. V. Ball.*
12568 ,,	Dharma	*C. H. Dreyer, Esq.*
16764 ,, TYPE.	Near Purulia, Manbhum Dist.	*Dr. N. Annandale*
16765 ,,	,, ,,	,, ,,

CENTRAL PROVINCES.

249 (spirit)	Raipur	*Dr. W. T. Blanford.*

MADRAS PRESIDENCY.

15990 (spirit)	Gopkuda I., Lake Chilka, Ganjam.	*Museum Collector.*
15991 (skl. & skull)	,, ,, ,,	*Dr. W. T. Blanford.*
520-1 (spirit)	Godavari River	,, ,,

Emyda granosa vitata, Peters.

MADRAS PRESIDENCY.

13497 (spirit)	Coconada, Coromandel Coast.	— *Mairguy, Esq.*

263-5 (spirit)	Travancore	*Prince Rama Varma.*
254-6 ,, 1022 (skl.)	Madras	*Madras Museum.*
16689 (spirit): juv.	Bangalore (3,000 ft.)	*Dr. N. Annandale.*

BOMBAY PRESIDENCY.

1660 (skl.): 1043 (skull)	Cutch.	*Dr. Stoliczka.*
247-8 (spirit): 566 ,,	Goa	*Purchased; Dr. J. Anderson.*
1774 (skull)	Sind	*Dr. W. T. Blanford.*

Emyda granosa ceylonensis, Gray.

280-2 (spirit)	Ceylon	*Dr J. Anderson.*
1025-6 (skl.)	,,	*Dr. Kelaart.*
1043 (skull)	Colombo	*Dr. J. Anderson.*

Emyda granosa scutata, Peters.

1705-7 (skl.)	Burma	*Hon. A. Eden.*
783 (skull)	,,	,, ,,
266-7, 269, 3885, (spirit): juv.	,,	*Hon. A. Eden, Maj. Sladen, Dr. W. Theobald, Dr. F. Stoliczka*
268 (spirit): juv.	Moulmein, Lower Burma.	*Dr. W. T. Theobald.*
1708 (skl.)	Bhamo, Upper Burma	*Capt. Lowndens.*
1709 ,,	Mandalay, ,, ,,	*Maj. Strover.*

Lydekker (Pal. Ind. III (ser. x), p. 197 (43), 1886) states that *Emyda vittata*, Peters, occurs as a fossil in the Siwalik deposits of the Punjab and suggests that the Indo-Gangetic form (*granosa*) had not been produced when these beds were formed.

The shell he figures as that of the former, however, resembles the race *ceylonensis* (which he did not distinguish from *vittata*) in having the xyphoplastral callosities in contact for the whole of their length, agreeing in other respects well enough with *vittata*. It is not improbable that it actually represents a form from which both of the southern races have been evolved. The other fossil remains figured by the same author appear to have belonged to forms that were both less highly specialized and considerably larger than the modern ones. They show, however, that in Post-Tertiary times two types of plastral sculpturing had already become fixed. The North Indian and Burmese races may be descended from *Emyda sivalensis* or *E. palaeindica*, and there are indications that *scutata* possibly represents the latter species. If it could be proved that the different races of the one surviving species were derived from comparatively recent fossil forms that were specifically distinct from one another, it would be permissible

to cite them as instances of convergence produced by isolation, the ancestors of different species isolated by some means from one another having, in the absence of enemies and the presence of a liberal supply of food, tended to revert in general structure to their common but long extinct ancestor, while retaining certain unimpor-

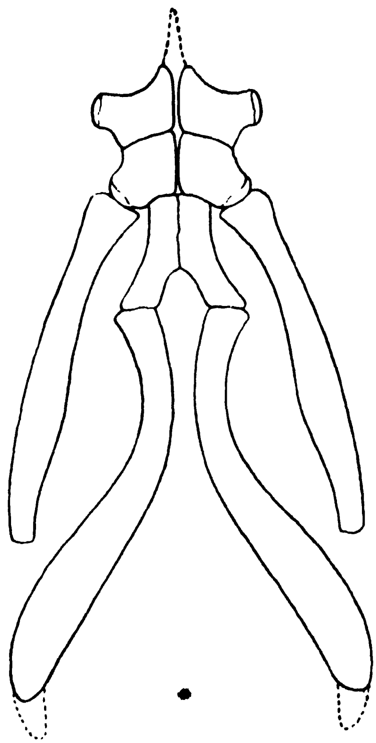


FIG. 5.—Branchial skeleton of *Emyda granosa*, × 2.

tant distinctive features. Theoretically it would be difficult in that case to regard such forms as local races of one species, but in practice this seems at present to be the only possible course to adopt, if we are to pay any attention to geographical considerations in distinguishing between subspecies and varieties. (See Annandale, Fauna Brit. Ind.—Freshwater Sponges, etc., p. 18, 1911.)

Species.	Sex.	Reg. Nos.	Length.	Breadth.	Orbit.	Snout.	Inter-orbital width.	Nasal aperture (width).	Post-orbital Arch.	Mandibular Symphysis.
T. gangeticus, Cuv. ..	..	1893	134 mm.	96 mm.	22 mm.	36 mm.	17 mm.	19 mm.	12 mm.	20 mm.
,, ..	..	1080	127 ,,	94 ,,	21 ,,	35 ,,	16 ,,	20 ,,	13 ,,	19 ,,
,, ..	♂	78	123 ,,	95 ,,	20 ,,	34 ,,	16 ,,	20 ,,	11 ,,	13 ,,
,, ..	..	16751	118 ,,	88 ,,	20 ,,	32 ,,	15 ,,	19 ,,	12 ,,	18 ,,
,, ..	♂	79	117 ,,	86 ,,	21 ,,	32 ,,	16 ,,	21 ,,	9 ,,	18 ,,
,, ..	♂	756	115 ,,	87 ,,	18 ,,	33 ,,	15 ,,	17 ,,	11 ,,	18 ,,
,, ..	..	1081	113 ,,	84 ,,	19 ,,	33 ,,	13 ,,	18 ,,	9 ,,	18 ,,
,, ..	..	1835	111 ,,	92 ,,	20 ,,	34 ,,	15 ,,	18 ,,	12 ,,	20 ,,
,, ..	..	1089	102 ,,	75 ,,	18 ,,	30 ,,	13 ,,	15 ,,	9 ,,	13 ,,
,, ..	..	1054	104 ,,	75 ,,	17 ,,	29 ,,	11 ,,	16 ,,	9 ,,	.. ,,
,, ..	..	1082	92 ,,	68 ,,	15 ,,	26 ,,	12 ,,	14 ,,	8 ,,	14 ,,
,, ..	♀	1083	92 ,,	63 ,,	17 ,,	25 ,,	9 ,,	14 ,,	7 ,,	12 ,,
,, ..	..	1084	89 ,,	62 ,,	16 ,,	23 ,,	9 ,,	13 ,,	6 ,,	15 ,,
,, ..	..	1052	88 ,,	62 ,,	16 ,,	23 ,,	10 ,,	15 ,,	7 ,,	15 ,,
,, ..	..	1085	74 ,,	51 ,,	14 ,,	18 ,,	7 ,,	11 ,,	5 ,,	.. ,,
,, ..	..	3870	84 ,,	58 ,,	14 ,,	22 ,,	8 ,,	12 ,,	5 ,,	.. ,,
,, ..	..	1051	88 ,,	60 ,,	16 ,,	23 ,,	10 ,,	14 ,,	6 ,,	13 ,,
,, ..	..	1086	77 ,,	52 ,,	14 ,,	19 ,,	7 ,,	11 ,,	5 ,,	11 ,,
,, ..	..	1727	68 ,,	48 ,,	14 ,,	17 ,,	7 ,,	10 ,,	3 ,,	11 ,,
,, ..	..	*16750	60 ,,	41 ,,	12 ,,	15 ,,	6 ,,	9 ,,	4 ,,	10 ,,
T. hurum, Gray. ..	♂	16752	129 ,,	87 ,,	21 ,,	38 ,,	16 ,,	19 ,,	14 ,,	30 ,,
,,[1] ..	♂	1090	125 ,,	87 ,,	23 ,,	37 ,,	18 ,,	18 ,,	13 ,,	.. ,,
,, ..	♂	1050	100 ,,	62 ,,	16 ,,	29 ,,	12 ,, ?	13 ,,	7 ,,	23 ,,
,, ..	..	1920	88 ,,	58 ,,	16 ,,	28 ,,	11 ,,	11 ,,	7 ,,	22 ,,
,, ..	♀	1047	83 ,,	49 ,,	14 ,,	24 ,,	11 ,,	10 ,,	7 ,,	20 ,,
,, ..	..	1049	70 ,,	41 ,,	13 ,,	20 ,,	9 ,,	9 ,,	6 ,,	15 ,,
,, ..	..	16627	72 ,,	43 ,,	13 ,,	19 ,,	9 ,,	10 ,,	4 ,,	16 ,,
T. nigricans, Andr. ..	..	1894	126 ,,	93 ,,	21 ,,	34 ,,	20 ,,	18 ,,	10 ,,	24 ,,
,, ..	..	1898	125 ,,	90 ,,	21 ,,	32 ,,	16 ,,	17 ,,	10 ,,	22 ,,
,, ..	♀	754	105 ,,	82 ,,	19 ,,	21 ,,	13 ,,	15 ,,	8 ,,	21 ,,
,, ..	..	1908	104 ,,	74 ,,	18 ,,	28 ,,	12 ,,	15 ,,	8 ,,	19 ,,
,, ..	♀	1918	? ,,	74 ,,	18 ,,	28 ,,	15 ,,	14 ,,	9 ,,	?
,, ..	..	1731	40 ,,	26 ,,	9 ,,	9 ,,	3 ,,	5 ,,	2 ,,	6 ,,
T. formosus, Gray. ..	..	1787	88 ,,	67 ,,	17 ,,	25 ,,	13 ,,	12 ,,	9 ,,	18 ,,
,, ..	..	1786	89 ,,	60 ,,	15 ,,	25 ,,	13 ,,	11 ,,	8 ,,	21 ,,
,, ..	..	605	87 ,,	56 ,,	16 ,,	24 ,,	12 ,,	11 ,,	7 ,,	?
,, ..	♂	1063	79 ,,	54 ,,	13 ,,	20 ,,	11 ,,	10 ,,	6 ,,	17 ,,
,, ..	..	634	59 ,,	42 ,,	12 ,,	16 ,,	7 ,,	8 ,,	4 ,,	13 ,,
T. phayrei, Theob. ..	♂	755	140 ,,	114 ,,	25 ,,	39 ,,	21 ,,	16 ,,	12 ,,	27 ,,
,, ..	..	1094	? ,,	128 ? ,,	25 ,,	42 ,,	21 ,,	20 ,,	13 ,,	26 ,,
D. subplanus ..	..	661	32 ,,	22 ,,	7 ,,	8 ,,	2 ,,	4 ,,	1 ,,	5 ,,
,, ..	..	13488	70 ,,	52 ,,	7 ,,	17 ,,	5 ,,	8 ,,	1 ,,	10 ,,

[1] Type of *T. buchanani*, Theob.

ADDENDA.

The following specimens have been added to the collection or assigned to their proper position since the foregoing paper went to the press:—

TRIONYX GANGETICUS (p. 157).

Bengal.

16791 (skl.)	..	Oodhua, near Rajmahal..	*B. L. Chaudhuri, Esq.*
16791 ,,	..	R. Mahanaddi, Sambalpur	,,
16712 ,,	..	,, Cuttack	*Mrs. L. de Monte.*

Central Provinces.

1087-8 (skulls: juv.)	Nasdo R. (tributary of the Mahanaddi), Bilaspur district.	*Dr. W. T. Blanford.*

TRIONYX HURUM (p. 160).

16781 (skl: skin of head in spirit).	Oodhua, near Rajmahal..	*B. L. Chaudhuri, Esq.*

This specimen agreed fairly well in coloration with the one (16627) from the same locality described on p. 162 but was rather darker.

EMYDA GRANOSA INTERMEDIA (p. 172).

Orissa.

16911 (skl.)	..	R. Mahanaddi, Cuttack..	*Mrs. L. de Monte.*
16785-6 (spirit.)	..	,, Sambalpur..	*B. L. Chaudhuri, Esq.*

Specimen No. 16785 is melanic, the whole of the dorsal surface being of an almost uniform black while the ventral surface is strongly tinged with dark pigment.

EXPLANATION OF PLATE V.

MANDIBLES OF INDIAN SPECIES OF *Trionyx*.

Figs. 1, 3, 4, 5 reduced; 1a, 2, 6 natural size.

FIG. 1, 1a, 2.—*Trionyx gangeticus*.
1, 1a. Old and young individuals from the R. Ganges;
2. Young individual from the R. Mahanaddi.

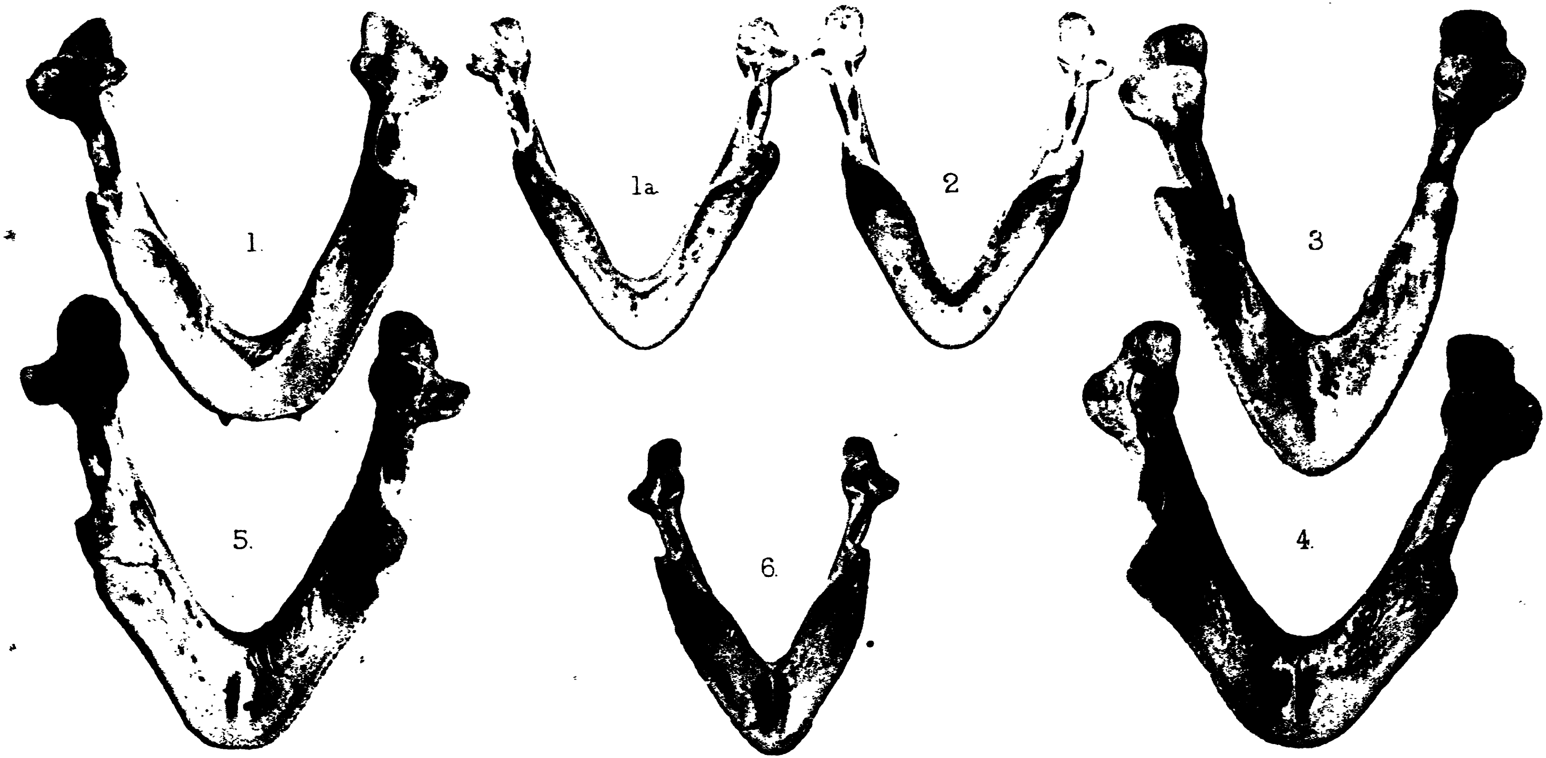
FIG. 3.—Adult of *T. hurum* from the Gangetic delta.

FIG. 4.—Adult of *T. phayrei* from Arrakan.

FIG. 5.—Adult of *T. nigricans* from Chittagong.

FIG. 6.—Half-grown individual of *T. formosus* from Burma.

[The small projections at the tip of the jaw represented in fig. 1 are artificial.]



Mandibles of Indian Species of Trionyx.

EXPLANATION OF PLATE VI.

All figures reduced.

FIG. 1, 2.—Skull and branchial skeleton of *Chitra indica*.

1. basihyal; 2, 3, 4. basibranchials; 5. greater cornu; 6. hypobranchial and ceratobranchial fused; 7. epibranchial; 8. pterygobranchial.

FIG. 3.—Type specimen of *Emyda granosa* subsp. *intermedia*.

1.

3.

2.

Figs. 1, 2. Chitra indica. Fig. 3. Emyda granosa intermedia, subsp. nov.

XVII. ON THE ANATOMY OF *ATOPOS* (*PODANGIA*) *SANGUINOLENTA* (STOLICZKA, M.S.).

By EKENDRANATH GHOSH, *L.M.S., B.Sc., Assistant Professor of Biology, Medical College, Calcutta.*

(Plates xxv–xxvii.)

INTRODUCTION.

The present article is based on several specimens of a slug collected more than forty years ago by the late Dr. F. Stoliczka in Penang[1] and at present in the possession of the Indian Museum. They have been placed at my disposal through the kindness of Dr. N. Annandale for anatomical investigation. Although left in alcohol for so many years, the animals were still in such a good condition as to allow me to make out the anatomical features in full detail with a few exceptions only. Having access to Simroth (12) and Collinge's (3, 4, 5, 6) publications, I took the opportunity of comparing the anatomy of other species of *Atopos* (of which *Podangia* is a subgenus) with that of the present species. As the animals had not been lately identified, it was necessary for me to consider the external characters fully and in minute detail, including the coloration. Unfortunately the colours of the animals have probably faded through long immersion in alcohol, but I have described them as they are at present.

Before passing on to the anatomy at once I shall try to find out the positions of the animals and the genus to which they most probably belong.

The specimens were placed in the family of Vaginulidae (Veronicellidae, Gray), order Pulmonata, under the name of *Veronicella sanguinolenta* by Stoliczka.[2] In 1891 Simroth in his admirable monograph (12) defined a new genus *Atopos* which he established for three species of *Vaginula*, Latrille,

[1] Apparently he obtained the specimens in the "more wild and deep ravines of the north-western part of the island." (Journ. As. Soc. Bengal (2) XLI, p. 261 (1872).

[2] Stoliczka probably referred to these specimens in his paper on the mollusca of Penang (1873), but he only named them in MS. Collinge in "A CHECK LIST OF THE SLUGS," published by Cockerell and himself (3), writes on page 223 "*Atopos pulverulentus* apparently includes a specimen in the British Museum from Penang (Theobold), marked '*V. sanguinea*, Stol.' It has the body beautifully marbled with black and grey, the sole pale orange-tinted. Length about 54 mm. Bluntly keeled." No date is assigned to *A. pulverulentus*, Benson, on page 195 of the same paper and I am unable to trace the description.

which is considered to be identical with *Veronicella*, Blainville (17). He also described the anatomy of these three species.

The genus *Atopos* is mainly defined by the following characters:

The body is thickest at the junction of the anterior one-third and posterior two-thirds, with a median keel on the dorsal surface of the mantle (notum); the transverse section of the body forms an isosceles triangle with a short base (formed by the foot); the female generative aperture is situated close to the anus and the renal and respiratory apertures in the groove between the mantle and the sole, a little behind the male generative aperture (although a little distant from it); the male generative aperture is situated behind the right lower tentacle.

Simroth also separated a few other species of *Vaginula* and placed them in a new genus which he named *Prisma*. The genus is characterized by the body of the animal being prismatic in transverse section.

Before the publication of Simroth's paper (12), Heude founded another genus *Rathouisia* for *Vaginulus sinensis*, the name of which he changed to *R. leonina*. The characters of the genus *Rathouisia* are briefly as follows:

The animals are elongated, limaciform; the mantle is not slimy; the upper tentacles are long; the lower tentacles are bifid; the posterior end of the foot is pointed, and extends beyond the mantle. The male generative aperture is placed behind the right lower tentacle. The female generative aperture rather approaches the male one, and is placed a little behind it, the anus and the excretory and respiratory apertures are placed close to the female generative aperture.

Later on, Heude united the genera *Atopos*, *Prisma* and *Rathouisia* to establish a separate family Rathouisiidae, characterized by a keeled mantle, male and female generative apertures distant and the anal and respiratory apertures placed near the female opening, in contradistinction to the absence of a keel, the position of the female generative aperture on the right in the middle of the body and that of the anal and respiratory apertures nearly at the posterior end of the body in the family of Vaginulidae (7, 11).

In 1900 Babor (2) established a new subgenus *Podangia* for *Atopos schildii* which differs from other species of *Atopos* in the following characters. The body of the animal is slender and high, with a distinct head separate from propodium. The foremost part of the notum is bent over the head covering it as a hood. The ommatophores (upper tentacles) are short, thick and distinctly annulated. Under each ommatophore is a crescent-shaped flap of integument produced into a process on each side and blended with the lower tentacle and the integument on the side of the mouth. The surface of the mantle is uniformly granulated with scattered tubercles in addition. The sole is small, with finely wrinkled border and with numerous

compact lobes. The groove between the foot and the mantle is shallow. The snout is elongated, with a small triangular mouth.

Taking the above characters into consideration, it seems to me that the animal belongs to the subgenus *Podangia*,[1] and as the colouring of the body differs from that of *P. schildii* it may be provisionally designated as *Atopos (Podangia) sanguinolenta*.

EXTERNAL CHARACTERS (pl. xxv, figs. 1 & 2).

GENERAL. The animal is elongated, limaciform. The body is compressed from side to side and is tapering to a point at the posterior end. The height and width of the animal is greatest at about one-fourth the length from the anterior end. The surface of the mantle is granulated uniformly and it also bears small scattered tubercles in addition. The tubercles are more numerous on the lateral aspect specially towards the margin of the mantle. The keel in the middorsal line is prominent but rounded. The margin of the mantle (perinotum) is sharp, wrinkled and inflexed. The foremost part of the mantle is bent over the head to form a hood-like covering. The anterior border of the hood is slightly notched. The posterior end of the mantle extends well beyond the foot. There is no distinct snout, the mouth being placed in a depression on the ventral aspect of the head The head is distinctly separate from the propodium. The ommatophores are short, thick, and cylindrical, and are marked with annular wrinkles, they seem to be non-retractile (i.e. non-invaginable), as in all the specimens examined they were protruded to their full lengths although a little bit contracted. The lower tentacles are short, contractile and are each connected at the base with a flap of integument (precephalic flap) beneath. Each precephalic flap is a continuation forward of the head from the ventral aspect and is separated from its fellow of the opposite side by a long narrow gap extending behind to a little in front of the mouth. The anterior border of the flap is thin and convex; the outer border is broadly S-shaped, being concave in front and convex behind; the antero-external angle is pointed and the antero-internal rounded (pl. xxv, fig. 4). The anterior end of the foot is truncated and is produced in front to form the propodium. The posterior end of the foot is narrow and pointed and it does not extend beyond the mantle border. The margin of the foot is produced into a thin rim. The sole is wrinkled irregularly with small

[1] The colouring of *P. schildii*, as described by Babor (2), is as follows:—The dorsal surface of the mantle (notum) is dark brownish grey, the foremost part of the mantle which forms a hoodlike covering of the head is of course pale. The head and foot are hazel-nut brown in colour.

The anatomy of *P. schildii* having been compared with that of *A. semperi* and *Rathouisia* in a few lines only, is of little use for the determination of the species.

lobules. The foot is separated from the mantle border by a shallow groove.

COLORATION.—The dorsum of the mantle is now reddish buff with dots and blotches of purplish black; of the tubercles some are of the same colour as the blotches. The lateral surface of the mantle is purplish black above, forming a broad longitudinal band with irregularly sinuous margins and of about one-third the height of the notum in width; this band is continuous with that of the opposite side round the anterior hood-like portion of the mantle; below there is another bluish black band with irregular margins, this is also continuous with that of the opposite side round the anterior end of the mantle by a narrower band of the same colour. The margin of the mantle (perinotum) is yellowish grey, with bluish black dots just below the band above. The ommatophores, lower tentacles and the dorsal surface of the precephalic flap are slaty blue. In life the colour of the dorsal surface of the mantle was probably bright red and the lower lateral band was probably dark blue.

MEASUREMENTS.—The animals having contracted in different degrees, and having been distorted by long immersion in alcohol, it is very difficult to get an accurate measurement to be of any use afterwards. Still it was thought best to note down the different measurements of all the specimens so as to form an idea of an average dimension. The length is taken along the midventral line after straightening the animal but without stretching it. The figure thus obtained was then compared with that resulting from measuring the animal along the midventral line in the distorted condition, and it was seen to be practically the same in both the cases. Another measurement is also taken along the keel from end to end. The width of the notum is taken to be the longest distance between the two lateral surfaces of the animal, and this is found to correspond generally to the junction of the anterior one-fourth and the posterior three-fourths of the body. The height of the notum is the longest perpendicular distance between the keel and the margin of the notum.

The measurements are given below in a tabulate form; they are all taken in centimetres.

Number of specimens.	1	2	3	4	5	6
Length along the venter	7·8	7·6	7	6·9	6·9	6·4
Length along the dorsum ..	..	10·9	9·1	10·2	9	8·8
Width of the notum	1·1	1·0	1·0	1·0	1·0	1·0
Height of the notum	1·4	1·3	1·2	1·3	1·2	1·2
Width of the foot	·7	·6	·65	·65	·6	·5
Distance of the male genital aperture from the anterior end of the foot ..	·3	·3	·3	·3	·3	·3
Distance of the female genital aperture from the anterior end of the foot ..	1·3	1·3	1·25	1·3	1·3	1·2
Length of the ommatophore ..	·3	·2	..	..	·2	·2
Length of the lower tentacle	·15	·15	..	..	·15	·15
Length of the cephalic flap ..	·4	·3	..	..	·3	·3
Width of the flap ..	·3	·3	..	..	·3	·3

ANATOMY.

I. Body wall (pl. xxv, fig. 3).

Minute structure.—The body wall consists of the following layers:

(1) The *epidermis* consists of a single layer of epithelium. The cells of the epithelium are columnar in shape and are placed side by side except at their extreme narrow ends of attachment, where they are a little separated from each other. The free borders of the cells are refractile and striated, but it is doubtful whether they are ciliated. The protoplasm is granular and is marked with faint longitudinal striations. The nuclei are large and oval, and are placed in the middle of the cells. The attached narrow ends of the cells probably contain brown pigment granules in some places. Between these epithelial cells are scattered fine ducts of unicellular

glands which are sometimes placed so close to the surface of the body that the epithelial cells over them become more or less flattened and displaced sidewise.

(2) The *dermis* or corium consists mainly of connective tissue with a few muscle fibres and unicellular glands. The glands are large flask-shaped cells generally placed beneath the epithelial layer. The cell-content consists mainly of the secreted materials with a little protoplasm and a small nucleus at the base. Immediately beneath the epithelial layer the connective tissue consists of large bundles of white fibres placed nearly at right angles to the surface and of smaller bundles which are branched off from the vertical ones and are spread horizontally in all directions. The fibres ultimately form a close network in the interstices of which lie the connective tissue cells. These are round, oval or fusiform cells with large nuclei. Some of these and others with branching processes contain brown pigment granules, which are densely placed beneath the epidermal layer. Beneath this are one or two layers of several muscle fibres scattered irregularly. The deeper layers of connective tissue consist of loosely arranged bundles of white fibres with a few yellow fibres and numerous connective-tissue cells. These cells are free from pigment granules.

II. RESPIRATORY SYSTEM (pl. xxv, fig. 5).

The pulmonary chamber is much atrophied; it forms a small oval sac lying in the anterior-third of the body beneath the right lateral wall of the mantle. It extends almost to the junction of the mantle with the foot below and stops short of the middle line above. The pulmonary chamber seems to open to the interior by an aperture placed at the antero-lateral corner to the right; the aperture is placed just behind the anus. The pericardium extends obliquely on the roof of the pulmonary chamber from the right antero-lateral towards the left postero-lateral corner. The kidney lies on the roof at the back. The roof of the pulmonary chamber is closely adherent to the inner surface of the mantle.

III. VASCULAR SYSTEM (pl. xxv, fig. 5).

The *pericardium* lies obliquely on the roof of the pulmonary chamber. The dorsal wall of the pericardium seems to be closely adherent to the body-wall.

The *ventricle* is placed in front of the auricle. The ventricle is a thick-walled pyriform sac with the ventral surface flattened

and the dorsal one convex. The *auricle* is thin-walled and is smaller than the ventricle.

Minute structure of the ventricle.—The ventricle is surrounded by a single layer of columnar epithelium. The muscles are arranged in various directions. The cavity of the ventricle is irregular and is traversed by numerous strands of muscle fibres. There is no epithelial lining in the cavity.

The *aorta*, just after its origin from the anterior end of the ventricle, divides into two; one passes forwards to the buccal bulb, while the other curves backwards and passes beneath the ventral aspect of the albumen gland closely applied to it, and seems to enter into the substance of the ovary; it also gives origin to several small vessels which supply the albumen gland.

The *pulmonary artery* (8) lies along the left side of the kidney, before it ends in the auricle; it receives numerous vessels from the kidney.

IV. KIDNEY (pl. xxv, fig. 5).

The kidney is a flattened triangular body lying on the roof of the pulmonary chamber at the back. In position it lies just over the accessory digestive gland to the right. The surface of the kidney is provided with a network of vessels which open into the pulmonary arteries. The margins of the kidney are thinned out and is continuous with the membranous wall of the pulmonary chamber. The ureter could not be traced.

In *A. strubelli* (10), the pulmonary chamber is a more or less round sac with the heart placed transversely and kidney to the left extending over more than half of the pulmonary chamber.

Minute structure.—The kidney consists of a mass of tubules which converge to open into the ureter which seems to lie along the right (?) side of the kidney. The tubules are long and wavy with wide lumen. They are all placed side by side with thin layers of intervening connective tissue. The wall of the tubules consists of a single layer of polyhedral cells placed on basement membrane. The nuclei of the cells are oval, and are placed at the bases of the cells.

The sections of kidneys from two specimens show numerous cystic bodies contained in the cells of the tubules. These cystic bodies, which are doubtlessly parasitic, seem to be the oocysts of a sporozoon. They are mostly round or oval, although many are irregular in shape. The wall seems to consist of a thick layer of cuticle which did not allow the staining fluid to penetrate into the interior. The cysts contain from one to six spores with distinct round nuclei. The spores are spherical, or facetted when there are more than one in a single cyst. The oocysts were too little advanced to show the formation of sporozoits. This sporozoon seems to belong to the genus *Klossia* (fam. Polysporocystidae, order Coccidiidea).

V. DIGESTIVE SYSTEM (pl. xxv, figs. 6–13, and pl. xxvi, figs. 14–16).

(i) The *buccal bulb* forms a tubular or elongated conical proboscis lying in a muscular sheath when retracted. The sheath opens on the ventral aspect of the head to form the mouth. The wall of the sheath is continuous behind with the wall of the buccal bulb just in front of the opening of the oesophagus into the latter.

(ii) The buccal bulb is continuous behind with a thick-walled conical sac which forms the *radula sac*. Collinge (3) describes the buccal bulb as divided into two portions lying respectively in front and behind the opening of the oesophagus. The radula sac is surrounded by a distinct muscular sheath.

The *radula* (pl. xxv, figs. 11–13) is a wide ribbon-like structure which does not seem to extend far forwards in the proboscis. The teeth are arranged in **V**-shaped rows with the apex of v directed backwards. There is no central. The lateral teeth are uniform in shape except the two median ones which are slightly different from others. There is no marginal. There are never less than 19 teeth on each side of the middle line. Each tooth is unicuspid and presents a shallow cup-like process in the middle.

The teeth of the radula in *A. strubelli* (10) are similar to those of the present species except that there is no cup-like process in the former.

(iii) The *salivary glands* could not be found in the specimens dissected They were described in several species of *Atopos* by Collinge (3, 4) and Simroth (12). Each gland was described to consist of a glandular mass and a long duct opening into the bucca bulb just behind the attachment of the muscular sheath on the ventral aspect. In *A. sarasini* (4), the two glands unite to form a single mass, although the two ducts are separate.

(iv) The *oesophagus* (pl. xxv, fig. 6) is a narrow tube arising from the dorsal surface of the buccal bulb behind the proboscis-sheath in the middle line or a little to its left. It then takes a U-shaped curve the bend of which is directed to the left. The tube then curves to the right, and down the side and ventral aspect of the anterior end of the radula sac to the mid ventral line, and then sharply turns forwards for some distance beneath the proboscis-sheath. It again turns backwards and passes beneath the short intercerebral connective to the undersurface of the digestive gland into the cavity of which it opens a little in front of the junction of the anterior one-third and posterior two-thirds of its length.

In *A. maximus* (3), the oesophagus passes to the left and then takes a U-shaped curve to pass beneath the radula-sac, it then passes backwards and to the left beneath the intercerebral connective to the under surface of the digestive gland and opens into it at a point about one-fourth the length of the gland from the anterior end. In *A. sarasini*, the oesophagus takes a similar sigmoid curve, but passes to the right at first and

then to the left. In *A. leuckarti* and *A. strubelli*, it ends in the anterior end of the digestive gland.

Minute structure (pl. xxv, fig. 10).—The oesophagus consists of the following coats from without inwards:—

(1) A thin layer of connective tissue consisting of a few white fibres and elongated fusiform connective tissue cells. Just beneath this layer are seen two nerves (oval in transverse section) passing along the sides of the ventral surface of that portion of oesophagus which passes backwards from beneath the intercerebral commissure to the digestive gland.

(2) Alternate layers of longitudinal and transverse muscle-fibres with loose connective tissue intervening between them. The fibres do not form continuous bundles, but are arranged irregularly. The fibres of different layers often communicate with one another. The bundles become smaller and smaller as we pass inwards. The longitudinal fibres become predominant on the inner side and form several longitudinal folds generally nine in number, which project into the cavity of the tube.

(3) The mucous membrane consists of a single layer of columnar epithelium. The cells seem to be ciliated.

(v) *The digestive gland, mid-gut gland* or *liver* (pl xxv, figs. 6 and 8) is a large elongated conical (or fusiform) body wide and rounded in front, but tapering and pointed behind. It occupies more than the posterior two-thirds of the body. In front it lies in connection with another small gland, the accessory digestive gland, and it is connected at its hinder end to the terminal body-wall by strands of connective tissue. The outer surface of the gland is smooth, but presents some transverse fissures. The inner surface is raised into numerous folds and papillae which increase the absorbing surface to a great extent. The wall of the gland is thick, and the gland is circular in transverse section.

In *A. strubelli* and *A. semperi* (10), the outer surface of the gland is finely lobulated but the inner surface is smooth and circular in transverse section. In both the gland is of dark colour and is conical in shape. In *A. leuckarti* (10) the gland is irregularly lobed and presents a process to the left from near the anterior end.

Minute structure (pl. xxvi. figs. 14, 15). The whole gland is surrounded by a thin layer of connective tissue (consisting of white fibres and connective-tissue cells). This ensheathing layer gives off numerous strands which converge and pass inwards to form the core of numerous papillae and folds which project into the cavity of the gland. These strands consist of connective-tissue fibres with a few muscle cells. These strands are surmounted by a single layer of cells which are placed side by side without any interspace between them. The cells are arranged to form

tubular spaces (simple tubular glands) between the contiguous connective tissue strands. Each space communicates with the cavity of the digestive gland by a wide mouth. The epithelium consists of elongated ciliated cells with the nuclei placed at the base Numerous goblet cells are found between these ciliated cells. The bases of many of these ciliated cells are occupied by a number of amoeboid (?) corpuscles with large round nuclei.

The *accessory digestive gland* (pl. xxv, figs. 6, 8) is a small triangular body lying in front of the digestive gland. The ducts of this gland open into the intestine as the latter passes forward from the left side of the gland. In the drawing of the alimentary canal of *A. maximus* (5) ducts of two other glands (not represented in the figure) are shown to open into the digestive gland. Hence it might be inferred that the above gland opens into the digestive gland. No such glands seem to be present in *A. strubelli*, *A. semperi*, and *A. sarasini* (4.) The process from the digestive gland in *A. leuckarti* seems to be homologous with the accessory gland.

Minute structure (pl. xxvi, fig. 16.)—The gland is surrounded by a connective tissue-sheath. It consists of a large number of lobules held together by connective tissue. Each lobule consists of a group of irregularly polyhedral cells closely apposed to one another, although fine channels (with walls composed of connective-tissue cells only) are often found passing between the cells. The protoplasm of most of the cells is coarsely granular and is stained red with eosin. These are undoubtedly zymogen granules. The nuclei are oval or rounded, and are obscured in many cells by these granules. A small proportion of cells have clear protoplasm with finer granules and more distinct nuclei. The gland is richly supplied with blood vessels which are placed inside the lobules. They generally form bundles in the middle of the lobules.

(vi) The *intestine* is a stout but thin-walled tube arising from the left side of the digestive gland towards the ventral aspect and close to the opening of the oesophagus. It forms a U-shaped loop lying embedded on the dorsal surface of the gland and then passes along the left side or on the dorsal aspect of (figs. 6, 18) the accessory gland, over the groove on the albumen gland and vagina obliquely to end in the anus, which lies on the right side in the groove between the foot and the overhung margin of the mantle closely behind the female genital aperture.

In *A. strubelli* (10) and *A. leuckarti* (10), the intestine seems to be directly continuous with the oesophagus at the anterior broad end of the midgut gland, which opens into the gut by a wide aperture at the junction of the two. In *A. sarasini* (4) the intestine forms a M-shaped loop lying embedded in the wall of the gland and comes out from its anterior end. The oesophagus is continuous with the intestine with a wide aperture (at the junction) which communicates with the cavity of the midgut gland.

Comparing the alimentary canal of these slugs with that of the more typical groups of pulmonates, *e.g.* the land snails, it should be observed that in the present animal there is no distinct dilatation of the midgut in the form of stomach quite distinct from the liver, which opens into the gut by small ducts in contradistinction to the separate stomach and liver in the land snails. Here the stomach might be considered to have become incorporated with the cavity of the gland, the wall of which presents numerous tubular glands homologous with a separate digestive gland.

VI. Reproductive system.

As in other pulmonates, the male and female genital organs are united in the same individual. There is some difference in opinion about the connection between the male and female organs at their proximal ends. Simroth's (10) descriptions and figures of the genital organs of his three species show that there is a common hermaphrodite gland from which are given off the vas deferens and oviduct; this condition then corresponds to the second of three types of genital ducts described by Lang (8). Collinge (3, 4), however, could not find out any connection between the two in his specimens. Although I found the two organs separate from each other I have a good deal of doubt about the validity of Collinge's view for the reasons noted below. On examining under the microscope the stained sections of the organ which corresponds to what Collinge described as ovary, I observed spermatozoa in different stages of development to my full satisfaction in addition to immature ova. As I had only old spirit specimens to dissect, it occurs to me that the so called ovary is really a hermaphrodite gland the fine vas deferens of which I could not trace. As the hermaphrodite and albumen glands lie over the penial sheath it seems to me that the vas deferens, being very fine and small, gets torn as the above glands are lifted up from their position and are separated from the penial sheath. Still as I could find out no connection between the two organs in the several specimens I dissected, I leave the question for further consideration in future.

(I) Male genital organs (pl. xxvi, fig. 20).

(1) A fine thread-like tube (pl. xxvi, fig. 20*a*) opening into the posterior end of the penial sheath near the attachment of the retractor muscle of the penis. It lies along the left side of the penial sheath and the stout tube in front, and extends to near the external opening of the right Simrothian gland. The same arrangement is seen in both *A. maximus* and *A. sarasini* described by Collinge (4) who called the tube vas deferens. Considering the anatomy of the genital organs of other pulmonates, this tube seems to be homologous with the flagellum. This has

been described in *Helix pomatia* and other pulmonates of the same family (7, 8).

Minute structure (pl. xxvii, figs. 27 and 28).—The tube is composed of the following coats from without inwards:—

(1) A thin layer of connective tissue.
(2) A layer of longitudinal muscle-fibres.
(3) A layer of circular muscle fibres.
(4) A submucous coat of connective tissue (with a few muscle-fibres) raised into a number of longitudinal folds, generally ten, projecting into the lumen.
(5) A single layer of columnar epithelium with numerous goblet cells (secreting cells).

(2) The *penial sheath* consists of two portions: (1) A stout hollow spindle-shaped structure giving attachment to the retractor muscle at its proximal end; (2) a stout tubular structure arising from the distal end of the first portion and ending in the external aperture at the base of the right lower tentacle.

Minute structure. The tubular portion consists of alternate layers of longitudinal and transverse muscles arranged irregularly. The wall is thrown into large longitudinal folds, the core of which is formed mainly of longitudinal muscle fibres. The presence of these large folds shows the great extensibility of the penial sheath. The epithelium consists of a single layer of cubical (or short columnar) cells.

(3) The *penis* is a more or less cylindrical structure lying in the proximal portion of the penial sheath when retracted. The penis is attached to the sheath at the proximal end and is traversed by a fine channel continuous with the lumen of the tube described above, and opening into the tip by a small aperture.

(4) The *retractor penis muscle* is a short thick band extending from the inner side of the body wall on the right, a little behind the female genital aperture, to the proximal end of the penial sheath and penis.

(5) The *Simrothian glands* (pl. xxvi, figs. 19, 20a) are two tubular structures, one on each side, opening on the outer side of the lower tentacles, the right one being placed close to the male genital aperture. Each gland can be divided into four portions (1) a long stout tubular portion coiled in various ways; (2) a short narrow portion, also tubular in structure, coiled closely; (3) an elongated slightly curved conical portion continuous with the second one at the tapering end and ending in the next in a broad base; (4) a very short narrow tube with a small cylindrical process from the outer side

The structure of the Simrothian glands in *A. maximus* and *A. sarasini* resembles closely that of the present species except that there is no distinct fourth portion and the process arises from the proximal end of what corresponds to the third division

in the present species. There is no left Simrothian gland in *A. sarasini* (4).

Minute structure.—First portion (pl. xxvi, fig. 24).—The wall consists of the following layers from without inwards:

(1) A thin layer of connective tissue forming a sheath round the tube.
(2) A layer of large granular cells more or less cylindrical in shape and with large nuclei placed on one side; they are arranged radially and obliquely, being attached to the first layer at their outer ends and to the next by the inner. In a transverse section one finds several oblique sections of the cells. These seem to be muscle-cells.
(3) A layer of muscle-fibres arranged longitudinally.
(4) A layer of transversely arranged muscle-fibres.
(5) A layer of submucous tissue. It forms numerous folds projecting into the lumen. Small muscle-fibres can be traced into it from the fourth layer.
(6) The mucous membrane consists of a single layer of columnar epithelium.

Second portion (pl. xxvii, fig. 26).—The different layers are:

(1) An outermost layer of connective tissue
(2) A thick transverse layer of muscular fibres intermingled with white and yellow fibres.
(3) A single layer of cubical cells with round nuclei. The epithelium is not folded.

Two or more loops of this portion of the tube may be held together in connective tissue.

Third portion (pl. xxvii, fig. 25). The various layers are

(1) A layer of thick longitudinal muscle-fibres the individual fibres are separated by connective tissue.
(2) A thin transverse layer of muscle-fibres. some of these are continued into the folds of submucous tissue.
(3) A submucous coat of loose connective tissue thrown into ten or twelve folds.
(4) The mucous membrane consists of a single layer of columnar cells with oval nuclei.

(6) The external aperture of the male genital organ seems to be situated on the inner side of a triangular process between it and the base of the right lower tentacle.

(II) FEMALE GENITAL ORGANS (pl. xxvi, figs. 17, 18).

(1) The *hermaphrodite* gland is a large lobulated body lying closely apposed to the posterior end of the albumen gland. The dorsal surface is marked with a longitudinal groove for the

intestine. The ventral surface is concave and rests on the penial sheath.

Minute structure (pl. xxvi, fig. 21).—The gland is composed of a number of lobules held together by connective tissue, which forms a thin sheath round the whole gland and also extends between the adjacent lobules. Each lobule is oval in shape and gives rise to a duct of its own which unites with others from the adjacent lobules to form the main duct of the gland. The lobular ducts could be distinctly followed to the oviduct by the naked eye. Each lobule consists of a single layer of flattened epithelium supported on a thin layer of connective tissue (forming the wall), with a central cavity filled with mature ova and spermatozoa. Each lobule gives origin to both ova and spermatozoa from its wall.

In the formation of an ovum, a cell of the wall enlarges and becomes fusiform in shape; its free surface is covered by a single layer of flattened cells continuous with those of the wall of the lobule. When mature the ovum seems to lie free in the cavity of the lobule.

The cells which ultimately form the spermatozoa seem to divide into a number of round cells (primary sperm mother cells) which become aggregated on the surface of conical or round projections into the cavity of the lobule from its wall. In a section of the lobule one will see several projections, the centre of which consists of a mass of protoplasm with a large nucleus. The primary sperm-mother cells are arranged on the surface of the projections. What seems to occur is the proliferation of an epithelial cell so as to form a mass of round cells on the surface of one which grows more rapidly than others and forms the supporting cell. The protoplasm of this cell is highly granular, and it has got no distinct cell wall The primary mother cells seem to divide again to form groups of secondary sperm-mother cells for by careful examination of stained sections under the microscope one will find a second set of smaller cells grouped in a similar way and still attached to a supporting cell. The nuclei of these secondary sperm-mother cells become gradually elongated to form the head of the spermatozoa. The different stages of the change in shape of the round nucleus to a rod-shaped body could be easily followed in stained sections The protoplasm of the cell then elongates to form the tail of the spermatozoon. The mature spermatozoa then separate from these papillae and lie freely in the cavity of the gland in bunches.

The mature *ovum* (pl. xxvi, fig. 22) is completely surrounded by a single layer of flattened cells (with distinct nuclei) attached end to end. The protoplasm is coarsely granular. The large nucleus lies in the centre and presents a conspicuous nucleolus.

The mature *spermatozoon* (pl. xxvi, fig. 23) consists of a hook-shaped head and a long fine tail. The head is curved and pointed at the tip, but broad and rounded at the base. It is also curved twice before it ends in the tail, which is many times longer than the head.

(2) The *albumen gland* is an elongated body with the posterior end flattened and attached to the ovary. The anterior end is narrow. The upper convex surface of the gland is smooth, but present numerous transverse fissures. It is indented with a longitudinal groove for the intestine. The inner surface is concave and presents a depression for the penial sheath over which it lies.

Minute structure (pl. xxvii, fig. 29). The gland is composed of a number of lobules bound together loosely by connective tissue. Each lobule is formed by a group of tubular acini, each of which seems to end in a duct which unites with others to form a main duct opening into the oviduct. Each acinus is enclosed by a basement membrane. Inside it is the epithelium consisting of a single layer of polyhedral cells with large round nuclei placed towards the base. The inner free borders of the cells are broken and jagged. The inner two-thirds of the cells are filled with coarse granules. The cavities of the acini are filled with the secreted material which is stained deep blue with hæmatoxylin. The ducts of the acini are lined with columnar epithelium.

(3) The oviduct is a thin-walled tube passing through the substance of the albumen gland and emerges through its anterior extremity to end in the vagina.

Minute structure (pl. xxvii, figs. 30, 31). The wall consists of a thin outer layer of connective tissue which is continued into the centre of the longitudinal folds projecting into the lumen. Inside this layer is a coat of connective tissue cells with a few fibres between them. These are also continued into the folds and surround the central strands of connective tissue. The mucous membrane consists of a single layer of ciliated columnar epithelium.

(4) The vagina is a stout tubular structure slightly curved with the convexity downward and to the right. The upper surface presents a groove for the intestine.

(5) The receptaculum seminis is an oval body with a fairly long tubular stalk opening into the middle of the vagina on its side.

(6) The female genital aperture in which the vagina ends, lies in the groove between the foot and right mantle border at a distance from the anterior end of the body already noted in a tabular form.

VII. Nervous system (pl. xxvii, fig. 32).

The nervous system is of euthyneurous type. The ganglia are closely united to form a mass round the oesophagus. The cerebral ganglia are closely connected to each other by a short thick intercerebral commissure. The cerebro-pedal and cerebro pleural connectives are united to form a short thick band on each side. The buccal ganglia are placed on the ventro-lateral aspect of the hinder end of the proboscis-sheath at the junction with the radula-sac. The stomato-gastric connectives are long

The pedal and viscero-pleural ganglia of both sides are closely connected to each other to form a reniform mass. The aperture for the oesophagus is very small.

VIII. PEDAL GLAND (pl. xxvii, fig. 33).

Is a tubular structure lying beneath the central nervous system on the dorsal aspect of the foot. The external aperture of the gland lies in the middle line in the groove betwen the head and propodium.

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EXPLANATION OF PLATE XXV.

FIG. 1.—*Atopos sanguinolenta* (nat. size): 1, male genital aperture; 2, female genital aperture.

,, 2.—Ventral view (nat. size): 1, male genital aperture; 2, female genital aperture; 3, anus.

,, 3.—Section of the bodywall, × 460; 1, epidermis, 2, unicellular gland; 3, pigment-containing connective tissue cell; 4, connective tissue cell (without pigment); 5, 6, vertical strands of white fibres; 7, muscle-fibre; 8, subepidermal pigments.

,, 4.—Head (dorsal view), × 4; 1, precephalic flap; 2, lower tentacle (left); 3, ommatophore (left); 4, opening of the left Simrothian gland.

,, 5.—Pallial chamber, × 1½: 1, ventricle; 2, auricle; 3, kidney; 4, aorta; 5, boundary of the pallial chamber; 6, position of the right lateral border of the mantle; 7, position of the mid-dorsal line (of the mantle).

,, 6.—Portion of alimentary canal, × 2: 1, accessory digestive gland; 2, digestive gland; 3, wall of digestive gland cut open to show the internal cavity; 4, cut end of oesophagus; 5, oesophagus; 6, intestine; 7, vagina.

,, 7.—Buccal mass, × 2; 1, proboscis-sheath; 2, proboscis; 3, a portion of oesophagus; 4, radula-sac.

,, 8.—Digestive gland of another specimen, × 1; 1, accessory digestive gland; 2, intestine.

,, 9.—Longitudinal section through the buccal mass, × 3; 1, proboscis-sheath; 2, proboscis; 3, opening of oesophagus; 4, radula-sac; 5, radula.

,, 10.—Transverse section of oesophagus, × 105.

,, 11.—Portion of radula showing teeth, × 60.

,, 12.—Two lateral teeth of radula, × 105.

,, 13.—Two median teeth of radula, × 255.

A C Chowdhary, lith.

EXPLANATION OF PLATE XXVI.

FIG. 14.—*Atopos sanguinolenta*, portion of epithelial layer of digestive gland, × 105; 1, goblet cell.

,, 15.—A transverse section of the wall of digestive gland (diagrammatic).

,, 16.—Section of accessory digestive gland, (stained with eosin and haemotoxylin), × 255.

,, 17.—Female genital organs (dorsal view), × 2; 1, hermaphrodite gland; 2, albumen gland; 3, vagina; 4, visceral artery.

,, 18.—Female genital organs, etc. (ventral view, with vagina unfolded), × 2; 1, hermaphrodite gland: 2, albumen gland; 3, vagina; 4, visceral artery; 5, receptaculum seminis; 8, anterior limit of pallial chamber; 7, kidney; 8, ventricle.

,, 19.—Left Simrothian gland, × 2.

,, 20a.—Male genital organs, × 2; 1, retractor penis muscle 2, penial sheath; 3, right Simrothian gland; 4, flagellum.

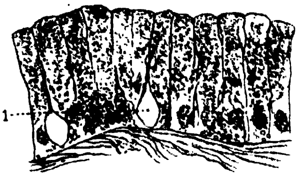
,, 20b.—Longitudinal section of penis and penial sheath, × 2; 1, penis; 2 penial sheath.

,, 21.—Section of hermaphrodite gland, × 124; 1, ovum; 2, sperm-mother cells; 3, developing spermatozoa; 4, free mature spermatozoa.

,, 22.—Section of a mature ovum, × 124.

,, 23.—A mature spermatozoon, × 756.

,, 24.—Transverse section of the first portion of the right Simrothian gland, × 50.



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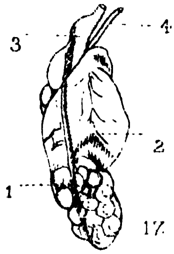

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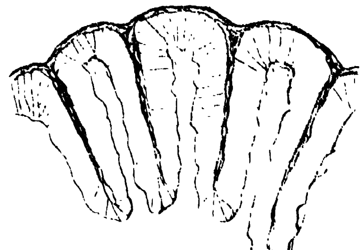
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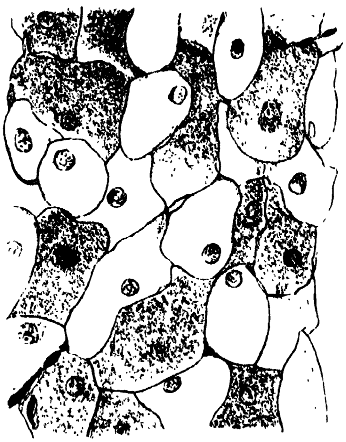
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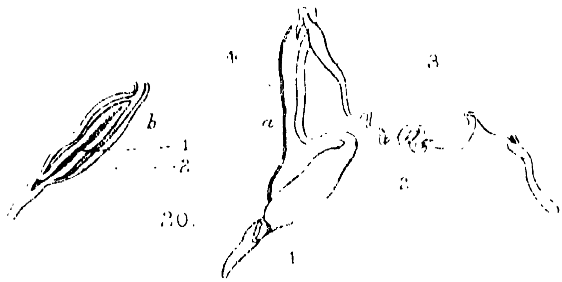

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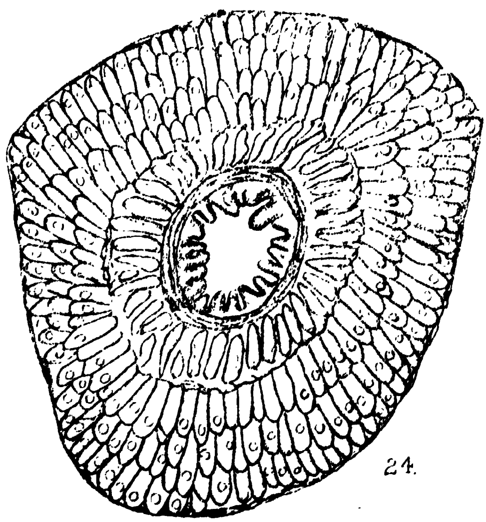
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EXPLANATION OF PLATE XXVII.

FIG 25a.—*Atopos sanguinolenta*, transverse section of the third portion of the right Simrothian gland, × 50.

,, 25b. A portion of the epithelial lining of the third portion of the Simrothian gland, × 460.

,, 26.—Transverse section of the second portion of the right Simrothian gland, × 50.

,, 27.—Transverse section of flagellum, × 255.

,, 28.—Portion of the wall of flagellum (transverse section).

,, 29.—Section of albumen gland, × 255.

,, 30.—Transverse section of oviduct, × 30.

,, 31.—Portion of a fold of oviduct as marked in fig. 30, × 255.

,, 32.—Nervous system, × 4; 1, cerebral ganglion (right); 2, right viscero-pleural ganglion 3, otocyst; 4, right pedal ganglion; 5, right pedal nerve ($\frac{1}{10}$th of the length).

,, 33.—Pedal gland, × 2.

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b.

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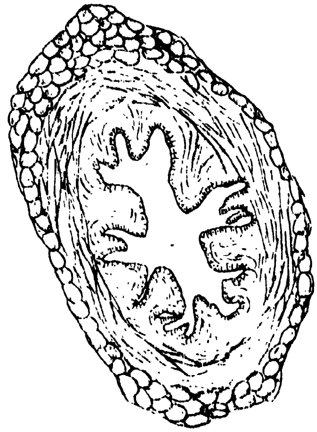

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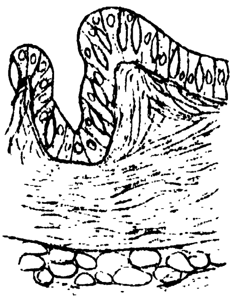

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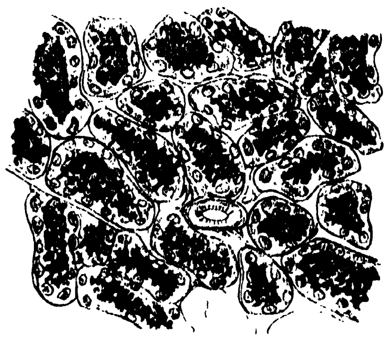

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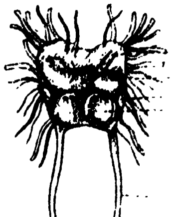

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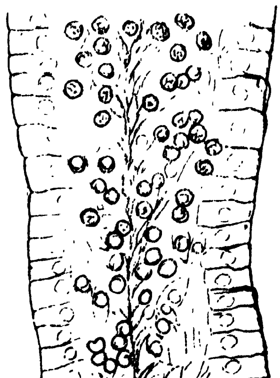


31.

XVIII. NEW CESTODES FROM INDIAN FISHES.

By JAMES HORNELL.

(Plates ix–x.)

I.—PROSTHECOBOTHRIUM UROGYMNI, n. sp.

II.—BALANOBOTHRIUM TENAX, n. gen. et sp.

III.—TETRARHYNCHUS ANNANDALEI, n. sp.

(1). PROSTHECOBOTHRIUM UROGYMNI, n. sp.

(Pl. ix, figs. 1–3).

Two specimens of this fine cestode were obtained from the spiral valve of a male *Urogymnus asperrimus* (Bl. Schn.), trawled in 9 fathoms on the north end of the Periya Par, one of the Ceylon Pearl Banks in the Gulf of Manaar, February 1908.

When alive the larger of the two measured 25 cm. in length, shortening to 14 cm. at death. The species is closely related to *P. dujardinii* (van Beneden), differing therefrom chiefly in its much greater size, the great elongation of the neck and the superior development of the suctorial loculi of the bothridia.

The scolex is furnished with four elongated sessile bothridia. Each is sub-lanceolate in outline, divided into three distinct loculi by two transverse muscular costæ. The most anterior loculus is considerably the longer being equal to the combined length of the two posterior ones. In life the mobile edges of the bothrium curve inwards and all three loculi are distinctly seen as deep sucker-like cavities; in this latter characteristic the present species exhibits a marked divergence from Diesing's type of the genus where the bothridia are described as undivided, each having a suctorial appendage at its posterior extremity. Johnston's description of the same species (*P. dujardinii*) necessitates a modification of the original generic diagnosis as he describes each bothrium as "really divided into three loculi by two transverse curved costæ," adding, however, that the most anterior loculus "is not apparently concave." The distal portion of each bothrium possesses a tongue-like mobility enabling it to twist and turn in search of a new holding when the living worm is dislodged from its attachment within the host's intestine. The tips of the bothridia may then be seen projecting prominently and at a considerable angle from the neck.

In anterior view the scolex appears sub-quadrangular, the thickened anterior extremities of the bothridia forming the four angles; as seen in figure 2 the bothridia extend some distance towards the centre of the "head," by their slight prominence forming a distinct cruciform depression upon the apical surface. The thickened anterior extremity of each bothrium bears a pair of double hooks; each consists of two sub-equal slightly curved long and slender prongs fused together by their bases. The curve in each prong is double—a light divergent curve from its fellow and a somewhat abrupt or right-angled curve on the under side whereby its holding power in attachment is increased. The acute-angled apex of the base of each double hook is approximated to that of its fellow in the same pair. The prongs project considerably and overhang slightly the anterior margin of the proximal bothridial loculi. In colour the hooks are dark brown and in appearance are chitinous. No accessory suckers or acetabula are present, thus differentiating this genus from the otherwise closely allied *Calliobothrium.*

The neck is very long and slender; about 0·4 mm. broad. The proglottides are extremely numerous and always markedly broader than their length. The width of the great majority, 0·75 to 0·9 mm., is characteristically almost twice as great as the length; a few at the posterior extremity as they ripen become somewhat more elongate and narrower. The lateral edge of the proglottides is slightly curved, the posterior margin very slightly produced and overlapping the front edge of the next succeeding. The genital pores are lateral. The general appearance and proportions of the strobila thus approximate closely to what is seen in *P. trygonis*, Shipley and Hornell.

It is noteworthy that the stomach contents of the host which yielded this cestode consisted (with the exception of a fragment of a Nemertine) of a great mass of one or more species of Amphioxus; there were hundreds of individuals in the mass. Other parasites present were *Tylocephalum [illegible]* [illegible] and Hornell, in great numbers, a single specimen [illegible] *[illegible]acanthus aetobatides*, and numerous individuals of an [illegible]named Nematode.

The dimensions of the [illegible] were:

Length of body to base of tail	..	..	3 ft. 1 in.
Breadth of disc	..	..	3 ft. 0 in.
Length of tail	..	.	1 ft. 8 in.

The diagnosis of *P. urogymni*, n. sp., is as follows:—Long slender cestode. Head elongated, twice as long as broad, armed with four large sessile, elongated and regularly disposed bothridia, each sub-lanceolate and trilocular with mobile edges and posterior tip; anterior extremity of each bothrium tumid, armed with a pair of double dark brown chitinous hooks. Prongs of each hook slender, equal, curved in two planes, the tips projecting beyond the anterior margin of the proximal loculus.

Neck very long and slender, proglottides very numerous, lateral margins lightly curved, posterior slightly overlapping, usually twice as broad as long, except a few of the most posterior. Length when alive up to 25 cm. Breadth of head under 1 mm.; of typical proglottides, 0·75 to 0·9 mm.

Habitat:—The large intestine of *Urogymnus asperrimus* (Bl. Schn.).

The characteristics of the genus *Prosthecobothrium* may now be amended as follows:—

Scolex with four elongated sessile bothridia divided by transverse costæ into three loculi; no accessory suckers on the anterior margins of the bothridia; a pair of double hooks on the anterior margin of each bothrium.

BALANOBOTHRIUM, n. gen.

Scolex acorn-shaped, consisting of a bulbous head surrounded at the base by a cup-shaped mobile membranous collar; a pair of very minute two-pronged uncini situated at four equidistant points on the upper circumference of the head, a minute acetabulum above each pair of uncini. Neck extremely short. Strobila ligulate, the proglottides short and wide.

(2). BALANOBOTHRIUM TENAX, n. sp.

(Pl. ix, figs. 4–6 and 8–10, and x, figs. 7, 11, 12).

This species has been found on two occasions in Indian seas, the first in 1905, when I found several small and immature ones attached to the spiral valve of a *Stegostoma tigrinum* (Gmel.) trawled on the Ceylon Pearl Banks: the second, in the intestine of an individual of the same host trawled in the Bay of Bengal by the Bengal Government Fishery Steamer "Golden Crown." Those obtained by the "Golden Crown" are much the larger and appear to have reached full development. In the dead condition they attain a length of 32 to 33 cm., three of the five specimens being within this range; the other two are shorter 18 cm. and 21 cm. respectively. Two of the largest are headless. The scolex consists of a bulbous sub-conical head contracted suddenly at the base to a very short and slender stalk from which a delicate membranous upturned cup-shaped collar is given off. In life the bulbous region of the scolex is wholly embedded within a sac-like diverticulum of the surface membranes of the host's intestine. This diverticulum hangs freely within the cavity of the intestine, its base greatly constricted. The os of its free end is minute and encircles closely the constricted base of the parasite's head bulb. In this way the head of the cestode is so firmly held that in removing the worm it is impossible to withdraw it uninjured from the sac and it becomes necessary to tear or cut away the sac at its junction with the instestine. In life the wide collar below the base of the head bulb functions as a suctorial bothrium, enfolding

and clasping the wall of the distal half of the intestinal diverticulum, so that a double purchase is assured—the diverticulum enveloping the parasite's head and the collar of the latter in turn enfolding the distal half of the hollow intestinal outgrowth (pl. x, fig. 11).

When freed from its adventitious envelope, the head is seen to be capable of considerable change of form and it is probable that by its alternate elongation and contraction it functions as a burrowing or penetrating organ, aided by the suctorial action of the bothridial cup which simultaneously anchors the worm securely in position. To supply the means of contraction well-marked muscle fibres pass from the constricted stalk and spread out over the walls of the head. The musculature of the encircling bothrium is weak, but radial and circular fibres appear to be present.

The head is armed in a peculiar manner with four pairs of minute two-pronged hooks situated at four equidistant points well anterior to its widest circumference. In the small and immature specimens obtained in Ceylon the two prongs of each hook are unequal and strongly recurved and rise from a common horizontal base, the larger from one extremity, the smaller from midway between the two ends. Opposite the base of the larger spine is a minute blunt spur-like process. In the large and fully adult specimens from the "Golden Crown" the common basal bar is stouter and wider and no "spur" is to be seen. So minute are these uncini that they cannot be seen until the head be mounted and examined microscopically and then a $\frac{1}{6}$th-inch objective is required to see the structure clearly. A low fleshy ridge runs backwards from the insertion of each pair of uncini, while immediately anterior to the interspace between the members of each pair is a minute acetabulum (pl. ix, fig. 8).

No definite neck region is present. Closely set grooves of incipient segmentation are apparent immediately behind the scolex; they gradually become more and more definite till the segments appear as distinct proglottides. These attain a maximum breadth of 4 mm. anterior to the terminal chain of ripening proglottides; in this region the length of each proglottis is approximately 0·8 mm. The mean breadth of a proglottis in the second and third quarters of the body may be stated at from five to six times that of its length.

The breadth of the strobila increases very gradually and with perfect regularity from 1·3 mm. in the anterior region to 4 mm. which it attains at the region where the proglottides begin to show a change of form, owing to the development of the gonads, about 3 cm. from the posterior extremity in the largest individuals examined. Thereafter the proglottides tend to decrease in width and become more elongate, but in none does the length become equal to the breadth. The ovaries are large and coarsely lobulated, arranged as a rosette of radially disposed pear-shaped lobes in the centre of the proglottis.

The genital apertures are lateral and placed well forward towards the anterior margin; the disposition is very irregularly alternate in series, that is, those pertaining to a number of consecutive proglottides, from two to six in number, may all open on the same side, to be succeeded by a number which open consecutively on the opposite side.

Both surfaces of the strobila are closely marked by transverse striæ; the lateral margins are almost straight, and there is no overlapping; sometimes the posterior lateral margin may be slightly salient and pointed.

The diagnosis of this species is as follows:—

Scolex consisting of a bulbous sub-conical head encircled at the base by a cup-like bothridial collar. Four pairs of minute two-pronged uncini disposed at equal intervals around the circumference of the head-bulb; the prongs are sharply bent at mid-length and borne upon a common horizontal bar; in young specimens a spur-shaped projection occurs opposite the base of the outer and longer prong.

No definite neck. Strobila ligulate, long and stout, 33 cm. in dead condition. Narrow at anterior end, 1·3 mm., increasing slowly and uniformly in width till it attains 4 mm. in front of the region of ripening proglottides.

Proglottides short, five to six times broader than long in the wide region posterior to mid-length; ripe proglottides characteristically short and length never greater than breadth. Grooves of segmentation apparent immediately behind bothridial collar. Cuticle striated transversely with minute furrows.

Ovaries arranged centrally in a rosette of large pear-shaped lobules. Genital pores lateral, opening well forward and anterior to mid-length; disposition irregular, in alternate consecutive series of from 2 to 6 on the same side.

Habitat: -The large intestine of *Stegostoma tigrinum* (Gmel.), Bay of Bengal and Gulf of Manaar.

The *type* specimens of this species are deposited in the Indian Museum, Calcutta, No. ZEV $\frac{1525}{7}$.

(3). TETRARHYNCHUS ANNANDALEI, n. sp.

(Pl. x, figs. 13–15a).

Associated with the specimens of *Balanobothrium tenax*, n. sp., described above from the gut of *Stegostoma tigrinum* (Gmel.) were two mature Tetrarhychids. These both measure 3·6 cm. in length (dead).

The head or scolex is well proportioned and about 8 mm. long. Anteriorly it has two well-developed simple bothridia of lappet form, 2 mm. in length by 1·6 mm. in breadth. They are somewhat fleshy in appearance, the border thickened and elevated and slightly emarginate on the posterior edge. Behind the bothridia, the head becomes slender, cylindrical and neck-like, 0·7 mm. wide;

this section is slightly longer than the bothridia. In this region the proboscidial tubules are seen in a prepared specimen to be long and closely coiled, predicating considerable length of the proboscides when extended (they are almost entirely withdrawn in both specimens examined). The posterior region of the head, containing the contractile proboscidial sacs, is characterized by its great relative length which equals the combined lengths of the bothridial and duct regions. It is also slightly wider. The four muscular sacs occupy the whole of this posterior head region; the fibres in their walls are arranged as usual in two sets crossing each other obliquely but in these species the criss-cross appearance so produced is particularly distinct and well marked.

Each of the four proboscides emerges from the summit of a minute perforated papilla situated near the anterior bothridial margin. Each bothrium bears two of these papillæ. separated from one another by a considerable interval.

None of the proboscides was sufficiently everted to enable the arrangement of the hooks to be clearly made out. The majority of them are of a sabre-like curve, distinctly stout and apparently laterally flattened. All are not of the same size, and there appears to be a certain variation in the proportions of these spines, some being shorter and more slender. A few extremely minute sharply curved stout hooks, strongly beaked, and with a large base (pl. x, fig. 15a) are also present

Immediately posterior to the contractile bulbs the worm increases abruptly though slightly in diameter to form a stout cylindrical neck; its surface is wrinkled transversely by a few irregular weak groovings. Its diameter is greatest anteriorly, gradually narrowing till it merges at a distance of one and a half its greatest diameter into the regularly segmented anterior region of the strobila. At first the segments are wider than long and the lines of division difficult to see; after the fifth they become square in lateral view and then gradually increase in length till they attain a length of twice their width. No overlapping occurs and the lateral margins are parallel except in those where the genital pore is developed.

The proglottides number about 25. The last seven are remarkable for the enormous development of the genital pore, in this closely agreeing with *T. macroporus*, Shipley and Hornell, which appears to be a closely allied species. In the present species, the pore is guarded by two great salient tumid lips. In all cases the pores are lateral, but their arrangement is very irregular. In the individual figured (pl. x, fig. 13), of the seven maturing segments, wherein pores are present, we have first one segment (the most anterior of the set) where the pore is on the right side as figured; in the three next succeeding the three pores follow each other consecutively on the opposite side (left) while in the terminal three proglottides, there is again a group of three pores following each other consecutively but this time it is on the right side, giving a formula of R 1, L 3, R 3.

The following measurements are from a specimen preserved in alcohol:—

	Millimetres.
Extreme length	36·00
Length of scolex without neck	8·00
Length of bothridia	2·00
Breadth do.	1·60
Length of region of coiled proboscis sheaths ..	2·00
Breadth do do ..	0·70
Length of contractile bulbs	3·80
Breadth of this region..	1·00
Length of neck	1·75
Breadth of neck at anterior end	1·25
Do. posterior end	1·00
Length of a mature proglottis ..	1·75 to 2·00
Breadth do. including genital eminence	1·20

This Tetrarhynchid is closely allied to *T. tenuicolle*, Rudolphi, and to *T. macroporus*, Shipley and Hornell. From the former it is sharply divergent in the much greater length of the contractile proboscidial bulbs, while from the latter it is equally sharply marked off by the form of the bothridia which is simple and entire in *T. annandalei*, whereas in *T. macroporus* each is divided into halves. The proboscis hooks in the latter appear also to be shorter and stouter and it is stated that there is practically no neck. In both the latter species the relative proportions of the two regions of the head are nearly the same and there is also approximation in the number and general form of the proglottides and in the great prominence of the lips of the genital pore.

Diagnosis of *T. annandalei*:—

Length 3·6 cm. Head cylindrical, and fairly long, about 8 mm. Bothridia two, lateral, longer than broad, slightly emarginate on the posterior edge and with a raised and thickened margin. Proboscides four, long, and strongly armed with curved hooks, the majority long and sabre-shaped, fairly stout; a small number of very minute recurved forms with elongated base also present.

The proboscis sheaths long and arranged in closely set spirals; this region of the head including with it the part overlaid by the bothridia is about equal in length to the posterior section containing the contractile sacs. *The latter region is characteristically of great relative elongation* and is slightly wider than the anterior head region. The sacs are cylindrical, with the oblique decussation of the muscle fibres well marked. Neck short, one and a half times as long as wide; greatest breadth seen in this worm occurs in the anterior part which increases in width abruptly immediately behind the contractile sacs. Neck wrinkled slightly transversely.

Proglottides about 25. Anteriorly they are wider than long, but soon become square and then rapidly elongate and in the matur-

ing ones length is twice the breadth. The lateral margin parallel, and none of the proglottides overlap. Cuticle sometimes faintly ringed but this may be a *post mortem* effect.

Last five or six proglottides remarkable for enormous development and prominence of the genital pore. This is lateral and situated at beginning of posterior third of the marginal length of each proglottis. Position of the pores are alternate in consecutive groups, usually in alternate series of 3, *e.g.*, right 1, left 3, right 3.

Habitat :—Intestine of *Stegostoma tigrinum* (Gmel.), Bay of Bengal.

Type specimen in the Indian Museum, Calcutta, No. ZEV $\frac{5020}{7}$.

I have pleasure in naming this elegant form after Dr. Annandale who has done so much to extend our knowledge of Indian Marine Zoology.

EXPLANATION OF PLATE IX.

FIG. 1.—*Prosthecobothrium urogymni*, n. sp.
Lateral view of head, × 50.

,, 2.—Head of the same, viewed from the anterior aspect, × 55.

,, 3.—Outline sketch of proglottides of the same from median region of body, × 40.

,, 4.—*Balanobothrium tenax*, n. gen., n. sp.
Lateral view of the head of an immature individual showing collar turned back. Sketched from life.

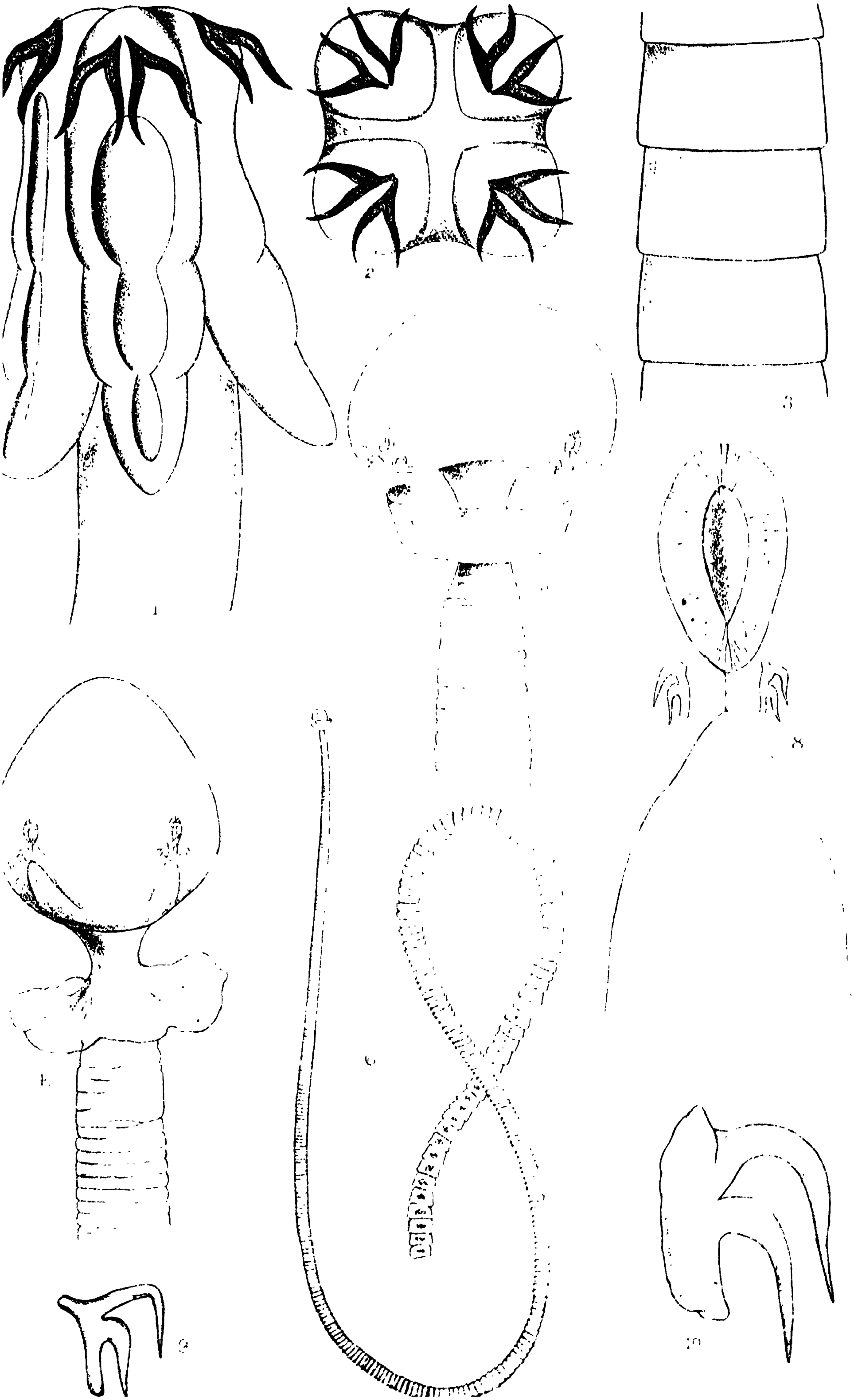
,, 5.—A second view of the same, to show another form frequently assumed when alive.

,, 6.—A fully mature individual of the same species. Natural size.

,, 8.—View showing the relative positions of each pair of uncini with the minute acetabulum anteriorly and the tumid ridge posteriorly, × 200.

,, 9. An uncinus from a young individual of the same species.

,, 10.—An uncinus from an adult individual, × 800.



EXPLANATION OF PLATE X.

FIG. 7.—*Balanobothrium tenax*, n. gen., n. sp.
View of head; the collar shown transparent to exhibit the base of the head bulb, × 17.

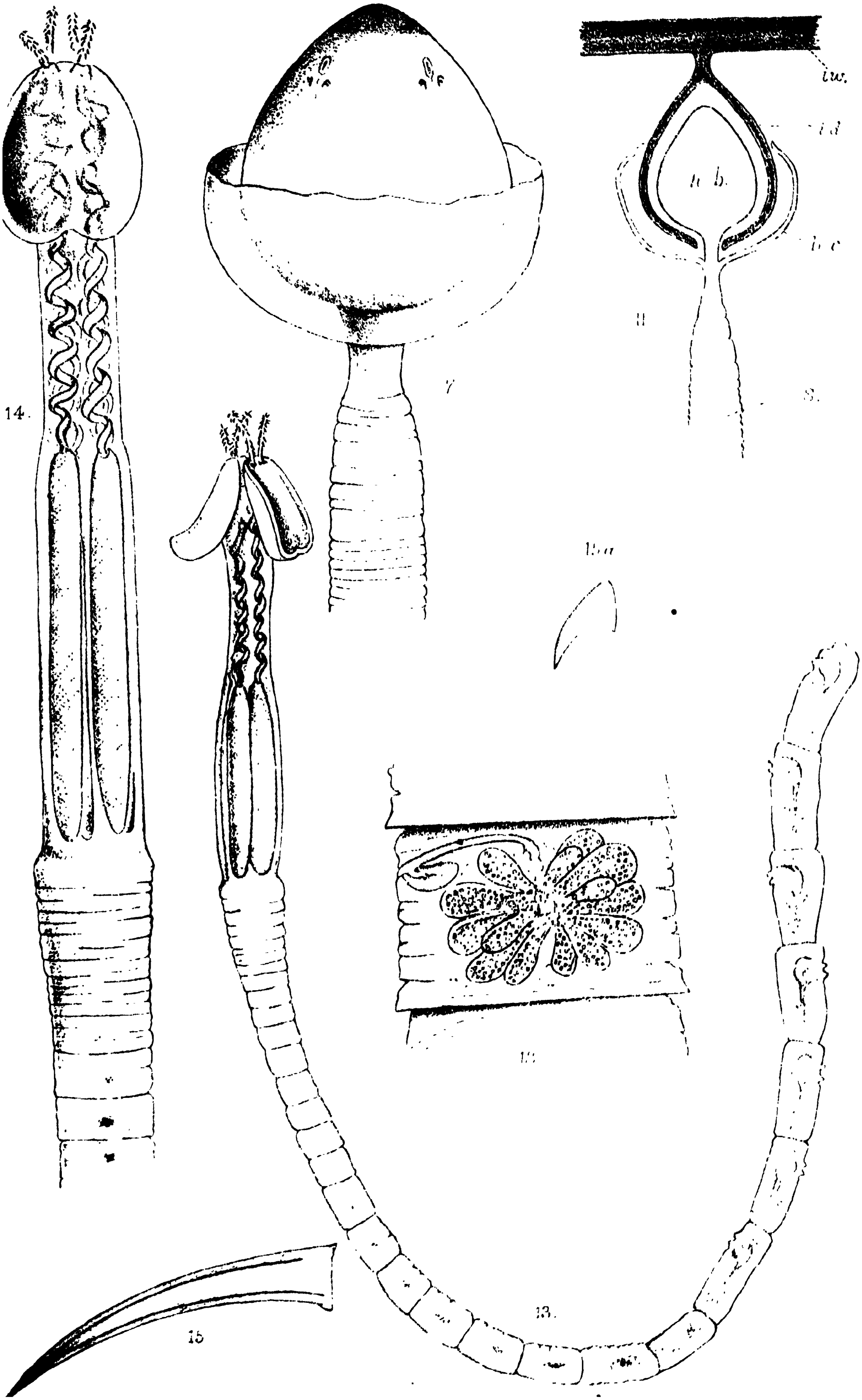
,, 11.—Diagram of a vertical section through the head of the same species when contained within a sac formed by an outgrowth from the intestine of the host, *i.w.*, wall of the intestine; *i.d.*, saccate diverticulum from inner wall of intestine; *h.b.*, head bulb of the cestode; *b.c.*, its bothridial collar; *s.*, anterior end of strobila.

,, 12. A ripening proglottis from the same species showing the rosette-like ovary with vagina and penis sheath anteriorly on the left, × 11.

,, 13.—*Tetrarhynchus annandalei*, n. sp., × 8·3.

,, 14.—Head of same, × 16.

FIGS. 15 & 15a.—Same. Hooks of proboscis, highly magnified.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MISCELLANEA.

POLYZOA.

THE OCCURRENCE OF ENTOPROCTA IN INDIAN WATERS.—On the stems of specimens of the Hydroid genera *Bimeria* and *Tubularia* collected at Port Canning on March 10th, 1912, I fin l a minute entoproctous polyzoon that appears to be specifically identical with Busk's *Barentsia* (or *Ascopodaria*) *discreta*, a species originally found at Tristan da Cunha in 100 to 150 fathoms by the "Challenger" Expedition (Busk, *Zool. Rep.* "*Challenger*," vol. xvii, part L (Polyzoa II), p. 44, pl. X, figs 6–12), but recently recorded from Ceylon by Miss L. Thornley, apparently from shallow water (Herdman's *Rep. Ceylon Pearl Fisheries*, part iv, p. 128). My specimens are much smaller than the type-specimens, the full-grown heads measuring only about 0·21 mm. in length and 0·18 mm. in transverse diameter, the same measurements as given by Busk being 0·5 and 0·4 mm. The length of the stalk and the proportions of the muscular bulb at its base vary considerably and the zoaria are colourless. Otherwise I can detect no divergence from Busk's original figures and description. Miss Thornley states that the specimens she examined were of a reddish colour. In view of the conditions under which the species was growing at Port Canning it is not surprising that it should be dwarfed, and I do not consider it advisable in the circumstances to give the phase a separate name. My specimens were found on Hydrozoa that grew on stones and logs partially embedded in dense mud at the edge of the river Mutlah. They were just uncovered by an unusually low tide. The water at the point at which they occurred contains in March about 25·46 *per mille* of saline residue.

Prof. K. Ramunni Menon has recently sent me a specimen of *Barentsia gracilis* (Sars) taken in Madras harbour. The species is common in Europe and has been recorded from the Pacific coast of N. America by Miss Robertson (*Proc. Calif. Acad. Sci.* (3) II, p. 344) and from Australian waters by Kirkpatrick (*Ann. Mag. Nat. Hist.* (6) II, p. 21, 1888).

The list of Entoprocta as yet known from Indian seas is a very short one, comprising, so far as I am aware, only three species:—

Barentsia gracilis.	Madras harbour.
,, *discreta*	R. Mutlah, Port Canning, Gangetic delta and Ceylon.
Loxosomatoides colonialis.	Brackish ponds, Port Canning.

N. ANNANDALE.

ANNELIDS.

NOTES ON THE REARING OF LEECHES IN MAWAI, BARA BANKI DISTRICT, UNITED PROVINCES.—[The leech to which the following notes refer has been identified by Mr. W. A. Harding as *Limnatis* (*Poecilobdella*) *granulosa* (Sav.)]

In this part of the country the leeches are abundantly found in ponds, streams, *jhils* and marshes but seldom in rivers.

The class of people who rear leeches are called "Chohra" and this occupation is the sole means of their livelihood. They use them for medicinal purposes; whenever any part of the human body is inflamed or its blood becomes impure the leeches are made use of to suck out the blood from the diseased part. This remedy is also prescribed with success in slight cases of blood-poisoning by native physicians.

The breeding season commences in April or May just before the beginning of the rains. The breeders pick out a few good adult specimens of leeches and put them in a new earthen pot with some pieces of a sort of black clay (called here 'hair-cleaning clay') with which people generally clean their hair, and sprinkle some water just sufficient to keep them wet. This vessel is closed and put away in a secluded corner of the house where there is no likelihood of any disturbance to the leeches. The breeders are of opinion that they do not form cocoons even if a man's shadow falls over them. This is merely putting stress on the fact that the leeches will not form cocoons if they are disturbed either by the footsteps of man or other accident. To avoid this people in certain places take the further precaution of burying the vessel containing them underground. Every alternate day the vessel is opened and some water is poured in to keep the clay wet.

In the course of a period which varies from a fortnight to a month the breeders find inside the vessel some foamy little whitish masses emitted by the leeches which within two or three days develop into oval-shaped cocoons, soft and partially transparent. As the cocoons get stiff they are carefully picked up and put into closed cups made of the clay already in the vessel. This process is kept up till all the soft cocoons have become hard and have been removed. The cups are changed every alternate day for a fortnight, when it is perceived that the young ones have developed within them. Then the shells are broken up by the breeders themselves in order to help out the weak ones which otherwise would die within the shell, not being strong enough to come out by themselves. Each cocoon contains five or six young ones.

The young ones are kept in fresh water which is changed morning and evening. This method of changing the water twice a day helps them to grow speedily. When the young ones grow sufficiently old to be able to suck blood (which is at once found out by putting a hand in the water as they rush to catch it) they are taken out and placed on some portion of his own body by the breeder, and after they have taken in a little blood they are removed and put back in the water. They are not allowed to

suck blood to their satisfaction, for if they do so they will immediately die. This process is repeated every fortnight until they grow old enough for the purpose for which they are reared. Then this new batch of leeches is divided into two lots, (1) that which is to be used for medicine and (2) that which is reserved for breeding. The latter are called 'seed leeches' and are kept in water which is regularly changed at intervals until the next breeding season sets in, during this period no blood is given to them. They are never used for money-making, for leeches once used for such a purpose are believed to lose their power of breeding.

Whenever the leeches are prescribed for medicine the *Chohra* (breeder) is sent for. He brings with him only those leeches that have not been used for two or three weeks and applies some of them to the intended part. The leeches at once begin to suck in blood with avidity, but if the blood has become mixed with pus they will immediately drop down. If it is not they will suck on till they fall down filled with impure blood, when they seem to lose all energy and look very dull and inactive. The breeder then takes these leeches one by one and pricks it with a needle just near the mouth on the middle line on the back and slowly squeezes out the blood commencing from the tail to the opening made by the needle. This, however, does not kill the leeches. When the trial is over the leeches are thoroughly rubbed by the hands which probably relieves them to some extent of the strain caused by squeezing, and restored to the water for future use.

The breeders are of opinion that the wild leeches do not breed in captivity until perhaps long used to it and it is even difficult to confine them unless they are carefully packed. Their bite when used for medicine is unbearable to the patient. This is not the case with the domesticated ones, the bite of which is comparatively less painful, much like that of an ant.

The leeches can be kept alive for many years if the water in which they are kept is occasionally changed, but those that have been used for medicine can hardly live for more than a year.

M. MOHSIN KHAN.

INSECTS.

THE HABITS OF SOME TIGER-BEETLES FROM ORISSA. Many species of tiger-beetles, though they may have a wide geographical distribution, are curiously particular in their choice of habitat. A well-known instance of this is *Cicindela biramosa*, Fabr., which lives only on the seashore, a fact sufficiently noticeable at such a place as Puri on the Orissa coast, but much more so near Balyghai, a few miles further north. Here the sandy beach on which alone this species lives slopes sharply up for a distance of perhaps twenty or thirty yards and then ends abruptly in a low wall of sand evidently produced by the action of high tides.[1] This wall forms the outer-

[1] I have only visited the place once as yet; this was towards the end of August 1911.

most rampart of a double or treble line of sand-hills running parallel to the sea, and behind these is a flat expanse of sand extending inland to a distance of about two miles and bounded on its inner side by the Sur Lake. With the exception of the green vegetation on the shores of the lake, and of some trees round a small temple on one of the sand-hills, *Spinifex* is the only plant rising above the surface of the sand, and this does not grow luxuriantly. The vegetation is principally composed of small plants lying close on the surface of the ground; except on the beach these occur more or less abundantly over the whole sandy area not affected by the lake. There is nothing resembling the long grass which is of such importance in the well-known Southport sand-hills in England during the early stages of their formation. In spite of this, the Balyghai sand-hills present a much greater appearance of stability than do those at Southport (an appearance in keeping with the nature of the vegetation), the sand being much firmer, probably on account of greater "binding" power. The shore therefore, though sharply marked off from the country out of reach of the tide, differs but little from it in character, and the way in which the darkly coloured and consequently conspicuous *Cicindela biramosa* confines itself absolutely to the former becomes peculiarly striking and suggests that the cause of its restriction must lie either in a restriction of its food to the area between tide-marks or in some effect of the sea on the climate of this particular area. I do not remember to have seen any tiger-beetles on the sand-hills; but there are some curious long-legged heteropterous bugs living there whose appearance and mode of progression is very like that of a tiger-beetle. On the sand further inland *Cicindela cancellata*, Dej., *C. albina*, Wdm., and *C. agnata*, Flt., occur, their markings blending with the general colour of the sand in such a way as to render them almost invisible. All three species may occur together, but their relative abundance differs greatly in different places; the last-named I found particularly plentiful on bare sand not far from the shores of the Sur Lake.[1]

Extensive floods occurred at about the time of leaving Balyghai and consequently the return journey to Calcutta was much impeded, and a night was spent at Cuttack on the way. By this time the floods had subsided again to a considerable extent, and among the bushes on the bank of the Mahanaddi (a big river crossed by the railway not far from Cuttack station) there were exposed at intervals little patches of firm sandy soil of not more than a few square yards extent each. On this dull soil numbers of tiger-beetles were assembled, and on more than one occasion I saw a specimen dig his jaws into the ground, from which I presume that he drew forth some food though I was unable to obtain confirmation of this. With the exception of one brightly marked

[1] Concerning the habits of the above four species see also Annandale in "Annotated list of the Asiatic Beetles in the Collection of the Indian Museum," Pt. I, pp. 13 and 28—30 (Calcutta, 1909).

specimen of *Cicindela venosa*, Koll.,[1] which was collected in the evening after dusk, the only species found in this situation were *C. angulata*, Fabr.,[2] *C. sumatrensis*, Herbst,[3] and *C. agnata*, Flt.[4], and it is perhaps noteworthy that every specimen caught was of a variety with dulled markings, whereas in the longer series of the last named species collected near Balyghai most were of the brightly marked variety. Whether or not these colour differences really depend on the environment I cannot definitely say; but most of the specimens from Balyghai were certainly collected on cleaner, dryer sand of a pale colour, and a beetle of this species collected on clean yellow sand on the bank of a stream near Chakardharpur in Chota Nagpur was of the most brilliant type; whilst two specimens of *C. sumatrensis* collected at the same place were both more brightly marked than those from the muddier sand by the river at Cuttack. Above the bank of the river at Cuttack there was an open grassy area on which the floods had deposited a thin layer of slimy mud. Although continuous with the more sandy river-bank it was inhabited only by two species of tiger-beetles neither of which were to be found there. These species were *C. cognata*, Wdm., and *C minuta*, Oliv. The latter being a small dark brown species was very inconspicuous on the mud, and evidently chooses mud-banks as its home, for on that part of the bank of the stream near Chakardharpur where the sand on which *C. agnata* and *C. sumatrensis* occurred was replaced by mud, these latter species were replaced by *C. minuta*. *C. cognata*, on the other hand, although dark coloured and not very large, was rendered conspicuous on the mud by its bluish colour, and I suspect that it normally inhabits grassy land such as this had been and would soon be again; for on such land its colour would blend excellently with its surroundings.

In conclusion I have to thank Dr. Horn for the identification of the beetles collected. Dr. Horn informs me that the tiger-beetles of Orissa are as yet but imperfectly known and suggests that all the species I collected there should be mentioned in this note. To those already referred to I have only to add *Collyris distincta*, Chd. var., on the label attached to which Dr. Horn inserts the note "palp. lab. ex parte rufis, cet." This form was abundant in a clump of trees close to the dak bungalow at Balyghai on the shores of the Sur Lake.

F. H. GRAVELY.

Schizodactylus monstrosus AS BAIT FOR BIRDS.—Perhaps the bait most commonly used by Indian bird-catchers and falconers for snaring insect-loving birds like the Roller, etc. is the mole-

[1] See Annandale, loc. cit., p. 13.
[2] See Annandale, loc. cit., p. 15.
[3] See Annandale, loc. cit., p. 14, where it is noticed that this species replaces *C. biramosa* at a short distance from the sea at Trivandrum just as *C. cancellata*, *C. albina* and *C. agnata* do at Balyghai.
[4] See Annandale, loc. cit., p. 13.

cricket (*Gryllotalpa*) called in the Punjab *ghū, ān.* Tethered by a thread to a peg it moves to and fro and by its restlessness attracts notice. It should however be kept in the shade as if exposed for many minutes to a fierce sun it will perish. Perhaps this is the reason that some bird-catchers prefer the great grass-hopper with curved wings (*Schizodactylus monstrosus*) called *Mirag* in the Chach-Hazara district and *labāna* [1] in the Punjab. For some of the smaller insect-eating birds it must be too large and terrifying, but it is said to be hardy and to stand the sun far better than its rival for favour, the mole-cricket.

D. C. PHILLOTT.

FISH.

Macrones menoda VAR. *trachacanthus* (Cuv. et Val.)—The specimen described below was received in the Museum for identification from Mr. Kinnear of the Bombay Natural History Society nearly a year ago, and as it showed some very interesting features and was a proof against Day's charge of misprint and wrong description concerning Cuvier and Valenciennes' species *B. trachacanthus*, it was thought desirable to wait for more specimens; but this short note need not be kept back any longer.

In all essential particulars, including the proportionate length of the barbels and the remarkable filamentous prolongation of the lower lobe of the caudal fin, this fish resembles the species which Cuvier and Valenciennes described in 1839 as a new species from Bengal in their Histoire Naturelle des Poissons, vol. xiv, p. 419, under the name *Bagrus trachacanthus*. The character of the lower lobe of the caudal fin was thus distinctly stated on page 420: "Le lobe inférieur de la caudale dépasse l'autre de près d'un tiers et se termine en filet."

Dr. Gunther in 1864 included this species of Cuvier's in a foot-note under the genus *Macrones* as one of the doubtful species (Brit Mus. Cat. Fish, vol. v, p. 75), but it was left to Day definitely to assert that Cuvier's description was a misprint and a wrong one, especially with regard to the filamentous prolongation of the lower caudal lobe. The specimen under examination refutes the charge and is a proof positive that Cuvier's description was not a misprint.

In 1822 Hamilton (Buchanan) published the plates illustrating his descriptions of the fishes of the Ganges. Below fig. 72 of Plate i of these illustrations the name "*Mugil corsula*" occurs in print. Edward Blyth in 1858, in supplying an additional description of the fish represented by this published figure of Hamilton (Buchanan) points out that under the original drawing of this fish of which fig. 72 is a print, the name "*Pimolodus menoda*" occurs in Hamilton (Buchanan's) own handwriting. Moreover fig. 97 of Plate ix of the same set of illustrations is correctly named "*Mugil corsula*," which is described by Hamilton (Buchanan) in his Gangetic Fishes under the same name (p. 221, Gangetic Fishes Text, and

[1] In Chach *labāna* is the name for small bird.

fig. 97, Plate ix of the Illustrations). The species *Pimolodus menoda* represented by fig. 72, Plate i, was described by Hamilton (Buchanan) on page 203 of the Gangetic Fishes, additional description being supplied by Blyth in 1858 as already alluded to above. Priority of the specific name "*menoda*" was recognized also by Gunther in 1864 in the footnote on page 64 of Brit. Mus. Cat., vol v. In spite of all this it is difficult to understand how in 1869 Dr. Day could describe this species under the name "*Macrones corsula*" (H. B.) based on Hamilton (Buchanan's) fig. 72 of Plate i of *M. menoda* and three specimens obtained from the Mahanaddi at Cuttack (Proc. Zool. Soc., 1869, p. 307). However, in this description of "*Macrones corsula*" no reference is made of Cuvier's species. But later on in the Fishes of India both the prior name *M. menoda* and Cuvier's *B. trachacanthus* are included by Day as synonyms of "*M. corsula*." In doing this he had several difficulties to encounter and explain away—the most obvious one of which he disposed of in a curious manner Whereas Hamilton (Buchanan's) species *M. menoda* in his description (Gangetic Fishes, p. 203) and in the drawing (fig. 72 of Plate i) was represented as having the upper lobe of the caudal fin longer than the lower—the lower lobe of the same fin of Cuvier's species was described by him to be filamentous and very much prolonged. Thus the only way by which Dr. Day could fit it in with his decision that it should be considered as the same species as his "*M. corsula*" was to declare that Cuvier's description about the filamentous prolongation of the lower caudal lobe was a misprint (Proc. Zool. Soc., 1869, p. 307). The specimen which is the subject matter of this note, however, proves that Cuvier's description regarding the proportionate length of the barbels and the filamentous prolongation of the lower lobe of the caudal fin is true and could not have been due to a misprint.

It is therefore identified as Cuvier's *trachacanthus* which must be regarded as a distinct variety, if not a species being included under Hamilton (Buchanan's) species *Macrones menoda* which through a mistake Day called "*Macrones corsula*" in the Fishes of India—the mistake being continued unnoticed in the Fauna of British India.

The specimen should therefore be identified as *Macrones menoda* (H B.) var. *trachacanthus* (Cuv. et Val.), for which the following short description may be supplied:—

Macrones menoda (H. B.) var. *trachacanthus* (Cuv. et Val.).

Depth of body $4\frac{3}{7}$ in the length, length of head 4. Snout $3\frac{3}{7}$ in the length of head, $1\frac{1}{2}$ as long as the eye the diameter of which is $4\frac{3}{5}$ in the length of head. Barbels eight, nasal extends far beyond the hind edge of the orbit, maxillary to middle of ventral, external mandibular to the middle of pectoral fin and internal mandibular to posterior extremity of opercle. Dorsal I 7, the posteriorly serrated spine is $\frac{3}{5}$ of the length of head. Pectoral I 9, spine posteriorly

denticulated, nearly as long as the head. Ventral 6, does not reach the anal. Anal 12. Caudal 17, deeply lobed, the lower lobe being much longer than the upper and ends in a filamentous prolongation. Adipose dorsal is high and pointed, length of the base being slightly shorter than the base of the anterior dorsal fin. Colour in spirit superiorly greyish brown and inferiorly dull white. Fins stained with black.

B. L. CHAUDHURI.

REPTILES.

AQUATIC TORTOISES OF THE MIDDLE GANGES AND BRAHMAPUTRA.—From enquiries from the actual catchers it appears that there are at least nine distinct species of water-tortises recognized by them in the beds of the Ganges up to Sahebgunge, the Kosi up to Jogbani (Anchra Ghat), the Mahanada in Maldah District and the Brahmaputra up to Goalpara. Of these six species were secured during a trip to Rajmehal undertaken in March, 1912. For the identification of the tortoises I am indebted to Dr N. Annandale.

Among the hard-shelled species four are distinguished:

1. The *Sál* or *Sal'* (*Kachuga lineata* (Gray) grows to three feet by twenty inches, weighs 20 to 30 seers and is easily distinguished by its larger size and very smooth and oily back from the *Dhoor* which is the common medium-sized species with rough back. The *Sál* does not breed and is not found with eggs until it reaches a much bigger size than the adult *Dhoor*. Two specimens of *Sál* were secured. Dr Annandale thinks that *Batagur baska* (Gray) is probably confounded with this species by the tortoise-catchers.

2. The *Dhoor* (*Kachuga dhongoka* (Gray)) is a smaller species than the *Sál*. It grows to sixteen inches by twelve inches and weighs eight to ten seers. It has a slightly rough back with pointed knobs in the middle line; the males are said to be very much smaller, not growing more than ten inches in length. The eggs are oval and very long, measuring 5·5 × 3·3 cm., and 30 to 35 are deposited at a time. Twenty-eight specimens of *Dhoor* were secured together with several eggs dug out of sand banks. Some individuals brought forth eggs while being packed. The shell of the egg is very brittle and there is a large air-space inside it, the external surface is obscurely pitted.

Both the *Sál* and *Dhoor* breed in March and deposit eggs on the sand bank of the Ganges but as they leave trailing marks behind, the hiding places of the eggs are easily discovered. Both *Sal* and *Dhoor* have long (oval) eggs, the *Sál's* being much bigger than those of the *Dhoor*. The young ones come out in May or June. They are occasionally caught in the fine nets in the month of June or July.

3. The *Chapaut* or *Chauputa* (*Kachuga smithii* (Gray)) is the smallest species but otherwise very similar to the *Dhoor*. It

does not grow to more than eight or ten inches in length and not more than a seer in weight. It deposits 5 to 8 eggs at a time and buries them in sand. Three specimens were secured.

4. The *Panchuria* (? *Kachuga tectum* (Gray)) similar to the *Chapaut*, is an intermediate species between the *Dhoor* and the *Chapaut*, growing to one foot in length and two seers in weight. No specimens of this species could be found on my trip.

5. The *Kala* or *Kali Kaunttha* of the Bengalis (*Hardella thurgii* (Gray)), is known as *Gaira* among the Gondris who are the expert catchers of tortoises. This species grows to two feet by fourteen inches and weighs 19 to 20 seers. The eggs of the species are not found in the sand bank on the Ganges, but are occasionally met with in the months of August and September, when the water subsides. The eggs are said to be oval. This species is also known as *Kariha* (or *Kariyaon*) among the Teors and Binds on the Kosi side. One specimen was secured.

Of the soft-shelled water-tortoises four species are recognized by the catchers.

6. The *Kataha* or *Kattha* of the Gondris and *Palaiva* of the Binds (*Trionyx gangeticus*, Cuvier) is a roundish low species growing to four feet by three feet and weighing two to three maunds. It brings forth round eggs which are found in the mud after the subsidence of the floods. The eggs are perfectly spherical, measuring 2·3 cm. in diameter. Some eggs were secured on a previous trip. This species is said to be good to eat. One specimen was obtained.

7. The *Keora* of the Gondris (*Trionyx hurum*, Gray) is a smaller species than the *Kataha*. It weighs twelve to fourteen seers, grows to sixteen inches by twelve inches in the disk, and brings forth round eggs. It is said to be very bad eating owing to its rank smell. One specimen was secured on this trip, and another on a former occasion near Rajmahal. Both are unusually pale in colour, lacking to a large extent the characteristic markings of the species. Dr. Annandale thinks it probable that they represent a local race distinguished from the typical one by a more uniform coloration and possibly by being smaller. In any case no structural difference likely to be constant can be detected.

8. The biggest of these soft kinds is the *Sim* (*Chitra indica* (Gray)) which grows to five feet in length of disk and weighs six to seven maunds. Like the *Kataha* it is to be found in the Kosi and also at Kustea and occasionally at Chilmari. It does not bite but disables its victim by blows, often injuring fishing boats by the impact thereof. It is bad and coarse eating. No specimen was secured, but there can be little doubt from the fishermen's description that *C. indica* is the species referred to under the above name.

9. The *Abhua* (*Emyda granosa* (Schoepff)), which is also known as *Matia* because it is supposed to subsist on earth, is a smaller species than the *Kataha*. In winter they are found peeping out of mud holes in the banks. It is said to be numerous

near Kánsàt (Maldah) and in the Gumani River (Murshidabad). It grows to one foot in length. No specimen was secured but there can be little doubt that the identification is correct.

The Santals, the great patrons of tortoise-consumption, recognize only two kinds. One is called *Lepra*, under which name falls *Kattha*, *Keora*, *Sim* and *Abhua* of the Gondris and the other *Hurum*, under which Santali name fall the *Dhoor*, *Sâl*, *Goira*, *Panchuria* and *Chapaut* of the catchers. Thus the distinction made by the Santals is a general one, whereas those of the catchers are evidently specific. It may be remarked here that the name *Hurum* is not applied to any of the soft species of water-tortoises in the Santali language.

The following fishing tribes were found catching tortoises in the bed of the Ganges near Rajmahal:—The Binds and Banpars catch them by *bansis* (hook and line), the Teors harpoon them, but the Gondris make a speciality of catching them in nets manufactured for the purpose. Tortoises, great and small, are often caught in the *Bara jal* along with all kinds of fish, but this is an accident and tortoises so caught are often thrown back into the river, as the Malas and Myfarases do not take any interest in them. It is forbidden to the latter people to eat them, while the former consider them unclean.

B. L. CHAUDHURI.

Culicidae and Corethridae in the Indian Museum. *Miscellanea* :—Measurements of the skeletons of two large Indian elephants in the Indian Museum. The young of *Aelurus fulgens*. Some Batrachia recently added to the collection of the Indian Museum. Breeding habits of *Tylototriton verrucosus*. The occurrence of *Rhinodon typicus* at the head of the Bay of Bengal. Note on *Ephydatia meyeni* (Carter).

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XIX. GORDIENS DU MUSÉE INDIEN.

Nouvelle Series.

Par Lorenzo Camerano, *Professeur à l'Université de Turin.*

Monsieur N. Annandale, Superintendant du Musée d'Histoire Naturelle Indien de Calcutta, a eu l'obigeance de me soumettre la collection de Gordiens appartenant au Musée. L'étude[1] de cette collection permettrà d'établir d'une manière plus exacte la distribution géographique de plusieurs espèces et fera connaitre aussi quelques espèces nouvelles pour la science.

Chordodes pollonerae, sp. nov.

Assam.

♂ Longeur, m. 0. 131. Largeur, m. 0. 001.

L'animal est de couleur brun-noirâtre.

La couche cuticulaire extérieure présente :—

1. Aréoles papillaires, dont la forme rappelle le fruit du mùrier (largeur 12, 13, 14 micromillimètres), leur contour est presque rond ou oval. Elles sont de couleur clair et sont très rapprochée entre elles.

2. Aréoles papillaires semblables aux précédentes : mais plus rélevées et de couleur plus foncé. Ces aréoles se trouvent isolées ou bien se réunissent, çà et là, par groupes de deux, trois, ou quattre.

3. Aréoles papillaires semblables aux précédentes mais munies d'un petit prolongement rèfringent. Ces aréoles sont assez rares.

4. Aréoles papillaires semblables a celles du numéro 2 mais plus rélevées et de forme conique qui entourent en nombre de 7, 8 ou peu plus, 1, 2 ou 3 aréoles papillaires de couleur plus foncé, rondes ou ovales, qui portent dans leur partie superieure des prolongements courts, fins, et réfringents. Je n'ai pas observé des prolongements en forme d'épines.

Parachordodes roccatii, sp. nov.

Majkhali, Almora district, Western Himalayas (*R. Hodgart*).

♀ Longeur, m. 0. 20; (l'extrémité antérieure n'est pas bien conservée).

Largeur maxima, m. 0. 0008.

L'animal est de couleur brun.

[1] L. Camerano, "Gordiens du Musée Indien," *Records of the Indian Museum*, vol. II, Part II, pp. 113—117 (1908).

L'extrémité antérieure est assez effilée. L'extrémité postérieure est plus grossie avec l'ouverture cloacale terminale et elle apparait comme tronquée obliquement.

Les aréoles de la cuticule extérieure (largeur 12 a 20 micromillimètres) sont un peu élevées, leur contour est presque rond. Parmis ces aréoles il y a des nombreuses formations réfringentes (largeur 5 micromillimètres) réunies deux par deux, qui donnent à la cuticule un aspect tout à fait caractéristique. Dans la ligue de separations, très petite, des deux formations on observe un petit tubercule réfringent.

Parachordodes kaschgaricus, Camer.

Shembaganur, Palni Hills, 6300 ft., Madura district, Madras Presidency. (*Major F. Wall, I.M.S.*).

♂ Longeur, m. 0. 220. Largeur maxima, m. 0. 001.
Coleur noirâtre.

Parachordodes pustulosus, Baird.

Sileuri, Cachar, Assam.

♀ Longeur, m. 0. 440. Largeur maxima m. 0. 0015.

Paragordius stylosus (Linstow).

Delhi, Punjab.

♀ Longeur, m. 0 142. Largeur maxima, m. 0. 001.
Couleur du corps brun clair. Le collier noir est peu marqué.

Gordius doriae, Camer.

Somaswar, 4700 ft., Almora district, Western Himalayas. (*R. Hodgart*).

♀ Longeur, m. 0. 195. Largeur maxima, m. 0. 001.
Le corps est de couleur brun clair. Le collier noir est bien marqué.

Gordius fulgur, Baird.

"From a tank at Badarpur, Assam (*B. Basu*). Local name *shut shanchar*. Supposed to be very poisonous."

♀ Longeur, m. 0. 550. Largeur maxima m. 0. 001.

XX. PRELIMINARY NOTE ON A NEW TORTOISE FROM SOUTH INDIA.

By J. R. HENDERSON, *M.B., F.L.S., Superintendent, Madras Government Museum.*

The tortoise which forms the subject of this note was obtained in Cochin State, on the Malabar coast, in October 1911, while I was engaged on a collecting tour in the dense State Forests, at a distance of about twenty miles from Chalakudi, the starting point of the forest tramway service. The Kadars, a jungle tribe who brought the first specimen to me, stated that it lived in the forest inhabiting a short underground burrow and that it did not affect the neighbourhood of water, a fact borne out by the absence of webbed digits. In addition to this specimen, a male apparently mature, which is described below, I subsequently obtained through the kindness of Mr. G. R. Grubb, M.A., M.I.C.E., Chalakudi, a second young example, but a Museum collector dispatched to the forests in March last was unable to find any others, so the species does not appear to be common. *Testudo travancorica*, Boulenger, is common in the same neighbourhood and I obtained a number of specimens. Both examples of the new species have been kept alive for over six months, during which time they have lived entirely on vegetable food. They have not shown any special partiality for water and when handled they do not emit an offensive odour as in the case of *G. trijuga.*

I have followed Stejneger and Siebenrock in substituting the earlier name *Geoemyda* for *Nicoria*, the latter being adopted by Boulenger in the volume on Reptilia in the Fauna of India series. As pointed out by Stejneger (Proc. Biol. Soc. Washington, XV, p. 237, 1902) the type of *Geoemyda* (Gray, 1834) is *G. spengleri*, and the same species was subsequently taken by Gray as the type of his genus *Nicoria* (1855).

GEOEMYDA SILVATICA, n. sp.

Carapace moderately depressed, tricarinate, with the median keel much more prominent than the lateral ones; the greatest height at the level of the posterior margin of the first vertebral shield. Vertebral shields broader than long, except the last in which the length and breadth are almost equal; vertebrals, particularly the first, wider than the costals. Nuchal longer than broad. Plastron of moderate width. Abdominal shields larger than the pectorals. The longest median suture is that between the

abdominals, but the one between the pectorals is only slightly shorter; the median sutures between the femorals and between the anals are sub-equal. No axillary or inguinal shields. Upper jaw with a median hook. Digits without a distinct web. Claws and limb tubercles well developed.

		mm.
Length of carapace (median line)	..	119
Greatest width of carapace ..	..	83
Length of plastron (median line)	..	98
Length of hind lobe of plastron	..	30
Width of hind lobe of plastron	..	53
Width of bridge	..	36
Depth of shell	..	45

The following are the colours in the living male specimen. Carapace, including the keels, uniformly black or almost dark bronze. Plastron dull yellow, with two spots on each bridge. Anterior portion of the head, including the upper and lower jaws, bright yellow with a red spot on the summit of the snout. Posterior portion of the head and also the neck brown. Iris red and a tinge of the same colour on the upper eyelid. Limbs and tail black.

Locality. Near Kavalai in the Cochin State Forests, inhabiting dense forest, at an elevation of about 1500 feet above sea level.

The new species is most nearly related to *G. tricarinata*, Blyth, a terrestrial tortoise occurring in Bengal and Assam, with which it agrees in the imperfectly webbed digits and yellow plastron, but in the latter the carapace is much more convex, the three keels are yellow, the upper jaw is not hooked and there are other well-marked differences. *G. trijuga* (Schweigger) the only other member of the genus hitherto met with in India, of which I obtained the striking variety described by Anderson as var. *coronata* (Anat. Zool. Researches, Yunnan, p. 720, 1878) at Chalakudi, is an aquatic species with many points of difference. In *G. spengleri* (Gmelin) from Japan, China, Borneo and Sumatra, which agrees with the new species in its depressed carapace and hooked upper jaw, the digits are webbed and the margins of the carapace are strongly serrated.

XXI. ON A NEW SPECIES OF BRANCHIODRILUS AND CERTAIN OTHER AQUATIC OLIGOCHAETA, WITH REMARKS ON CEPHALIZATION IN THE NAIDIDAE.

By J. STEPHENSON, *M.B., D.Sc. (Lond.), Major, I.M.S., Professor of Biology, Government College, Lahore.*

(Plates xi—xii.)

I received in November 1911 a tube of small aquatic Oligochaeta, sent to the Indian Museum from Madras by Prof. K. Ramunni Menon. The tube contained eight specimens, of which however one was a fragment incomplete at both ends. In one case the animal was in process of dividing asexually; none possessed sexual organs.

The worm belongs to the group of gilled Oligochaetes, and is closely related to the two Naids described, one by Bourne (4) under the name of *Chaetobranchus semperi* from Madras, and one by myself (15) as *Lahoria hortensis* from Lahore. Since gilled Oligochaeta are interesting on account of their rarity, and since the present form gives occasion for some remarks on the "cephalization" of the Naididae, I describe it here as far as possible in detail. My remarks go under four heads: (1) Anatomy, (2) Asexual reproduction, (3) Systematic position, (4) Cephalization in the Naididae. It is to be remembered that I have only had the opportunity of examining preserved specimens.

(1) *Anatomy.*

In length the worms were from 8 to 15 mm., they were brownish in colour; the two longest consisted each of 130 segments, plus a number of minute and scarcely differentiated segments in process of formation at the posterior end; another specimen had 77 segments with again a similar region of newly forming segments posteriorly. The gills were in most specimens just visible to the naked eye as processes on the anterior portion of the body. The prostomium was short and rounded. Succeeding the mouth was a short prebranchial region, which will be considered more fully below.

Gills.—The gills are elongated hollow evaginations of the body-wall; as in the related forms mentioned above, they contain a vascular loop, and, in the anterior portion of the body, the capillary dorsal setae also. Since they correspond in position with the dorsal setal bundles, they form a dorso-lateral series on each side. They diminish in size posteriorly, and the long dorsal setae are then no longer enclosed in them.

In the specimens in which the gills were best developed they were, in the most anterior segments, about ·54 mm. in length; but exact measurements are difficult, owing to their being somewhat curled and twisted; in the next succeeding segments, where they are longest, they were ·72 mm. long, or about 2—2½ times the diameter of the body in this region. In other specimens they were frequently not so long,—about ·27 mm., or equal to the diameter of the body.

Some idea of the progressive diminution in size may be obtained from the following data:—in an animal of 130 segments, the gills at the 40th segment were small finger-like lobes, at the 50th large tubercles, at the 60th small tubercles, and beyond this absent. In another specimen of 130 segments, they disappeared at the 76th segment; in one of 87 segments, at the 67th; they were present, as tubercles only, on the 73rd and 56th segments of two animals whose posterior ends had been destroyed at these levels respectively; and in another specimen they were quite small finger-like lobes on the 17th, and disappeared altogether beyond the 24th segment. Behind the region of the gills, in these preserved specimens, the series is continued as a pushing out of the body-wall, which is raised round the base of the dorsal setal bundles into small pointed conical elevations; but these are merely such as would be produced by a contraction of the muscles of the setal sac pushing out the bundles of setae, and indeed may have been so produced at the moment of fixation.

Pigmentation.—As in the related forms the anterior end of the body is markedly pigmented (pl. xi, figs. 1, 2, 3). The pigment occurs as irregular blotches on the prostomium and prebranchial region; behind this it has a fairly definite segmental arrangement, as irregular bands extending over the dorsal and lateral surfaces, but leaving the ventral surface free; the bands are formed of a number of irregular spots or blotches, which may or may not be confluent. The pigment may be very slight in amount and scattered in its distribution; in any case it fades away after the first few segments, e.g., beyond the 8th, 12th, or 13th.

Pigment also usually, but not always, occurs on the gills,—not all over them, but in streaks along their lateral aspects (pl. xi, fig. 1). The pigmentation of the gills corresponds roughly, as regards number of segments, to that of the body.

The pigment appears to be located in peritoneal cells lining the body-wall, and to be of the same nature as that of the chloragogen cells; similar cells invest the dorsal vessel as far forward as the second gill, and sometimes some of the lateral loops also [v. *inf.*, and cf. Bourne (4), and his fig. 3].

Setae.—The dorsal setal bundles begin with the gills; the setae are of two kinds, long and short. The long ('capillary') are straight, smooth, tapering gradually to a very fine point, and, where they are free from the gills and can be measured, in length commonly about 330 μ. The shorter ('needle') setae have typically the form shown in fig. 1; the distal curve and the

extremely slender extremity are (in preserved specimens) with difficulty visible with the ordinary high power, and an immersion lens is necessary to appreciate them. These setae are about 100μ long, and are closely applied to the proximal part of the shaft of the longer seta, the distal curved end of the short seta appearing to fit round the shaft of the longer. The point of the short seta may project slightly above the surface of the body in the middle and posterior regions of the animal's length.

In the most anterior part of the body, where the gills are longest, the setae are entirely enclosed in the gill processes. Here each bundle consists of two hair setae, or sometimes of only one; if there are two, one is much longer than the other. The hair setae are here much slenderer than they are posteriorly. This is the condition in the first 12, 13, 18, 26 or 27 gilled segments.

In the next succeeding region of the body the gills are becoming shorter, and the hair setae project freely and are no

FIG. 1.—*Branchiodrilus menoni*, dorsal needle seta; × about 375

longer contained in the gills. The bundles are composed of one hair and one needle. The transition from a thin to a thick type of hair seta is marked, and quite sudden. The needle has apparently not the typical shape described above; it is straighter, almost or quite without the distal curve, but it narrows rapidly to a fine point, like the curved form.

In the middle and posterior regions of the body the dorsal bundles consist of one hair and one needle, of the typical forms described above. Occasionally two needles occur in a bundle.

The ventral setae of the branchial and posterior regions of the body may be separated into two forms, though the distinction is not a hard and fast one, since intermediate shapes occur; neither is the distribution of the two forms fixed.

The one form, the more numerous, which may be designated the 'posterior,' is distinguished by a comparatively stout shaft, often a somewhat greater length, a nodulus distal to the middle of the shaft, and by having the prongs of the fork equal in length or the distal prong slightly longer (fig. 2). In length they measure

110 to 139 μ (proximal to nodulus : distal to nodulus : : 61 : 49. or 82 : 57). The other or ' anterior ' type is slenderer throughout, the prongs, especially the distal prong, also longer and slenderer; the distal prong is 1½ times as long as the proximal, while the

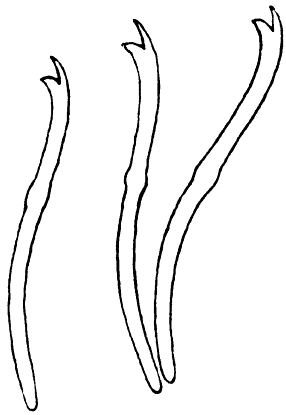

FIG. 2.—*Branchiodrilus menoni*; setae of the posterior ventral type; × 375.

nodulus is at the middle of the shaft or somewhat proximal (fig. 3). In length they measure 100 to 116 μ (proximal to nodulus : distal to nodulus : : 57 : 57, or 55 : 61). In both types the distal prong is only about half as thick at its base as the proximal.

The 'anterior' type occurs on a comparatively small number

FIG. 3.—*Branchiodrilus menoni*: setae of the anterior ventral type; × 375.

of the anterior segments of the body, the posterior type on the remainder; but there is no defined limit to their distribution. Thus well-marked ' anterior ' setae may be found on segment xiv, and even behind this; or nearly all the ventral setae in the body may be of the 'posterior' type. The change from 'anterior' to ' posterior ' is in any case not a sudden one, and may apparently

take place at a different level on the two sides of the same animal.

As to the number of ventral setae per bundle, this is usually three, and I have never seen more except in the one instance shown in pl. xi, fig. 4, where one of the bundles has four. Posteriorly there may be only two; and in some of the anterior segments also there may only be two. Very commonly in the anterior segments there were two fully formed setae, along with a half-formed seta, of which the proximal end was wanting,—as if it were still in process of formation, or perhaps rather as if its formation had been permanently arrested at this stage (cf. pl. xi, fig. 4).

Prebranchial region.—The region between the first gill and the mouth is in this species peculiar in several respects, and seems to merit special description. It may be recalled that in Bourne's worm dorsal and ventral setae begin at the same level (segment ii), the interval between mouth and first setae being equal, according to his figure, to about a single body segment; cephalization is therefore limited to the first segment. In the allied worm previously described by me there is a considerable interval between mouth and first gills; in this interval are situated the four first ventral setal bundles (exceptionally only three) but no dorsal setae; the gills and dorsal setae, therefore, begin on the sixth segment, and the first five segments are 'cephalized.'

In the specimens now under discussion, there is a moderate interval between the mouth and the level of the first gill, equal on the average (cf. pl. xi, figs. 1, 2 and 3) to the diameter of the body at the latter situation. No distinct external annulation could be made out in this interval; and the pigmentation was not segmentally arranged. The most curious point however is the varying distribution of ventral setae in this region.

The setae are always, when present, of a type distinct from those in the rest of the body. In their general proportions they resemble the 'anterior' setae, but are considerably shorter (77 to 87μ), remarkably slender, with delicate prongs, and a nodulus proximal to the middle of the shaft (proximal : distal : : 36 : 41, or 41 : 46).

Their distribution was as follows. In one specimen (pl. xi. fig. 1) there were four bundles of such setae in the prebranchial region; in another three (pl. xi, fig. 2); the condition in these specimens (except for the small size of the prebranchial setae) was therefore the same as in the related species previously described by me. In a third specimen there were on one side two setal bundles of only one seta each, the anterior of the two being the longer; on the other side there was, near the mouth, a single bundle of two setae; the prostomium in this specimen was fairly well formed, and the prebranchial region of considerable extent; i.e. considering the manner in which asexual division takes place in this form (v. *inf.*), this specimen had probably been leading a free existence for some time. In a fourth there was on one side a single bundle, of one seta only, situated nearer to the first gill than to the

mouth; on the other side there were no setae; the prostomium was very round, and the impression given was that the animal had not been long separated. A fifth specimen had no prebranchial setae on either side; the prostomium was very well marked, the mouth and the structures of the head in general were well formed; moreover this was the specimen in which asexual division was going on at the posterior end (pl. xi, fig. 4); it seems justifiable to suppose that this animal had been leading an independent existence for some time. A sixth specimen had similarly no prebranchial setae on either side; the setae of the first gilled segment were smaller and thinner than those of succeeding segments; the differentiation of the head end of the animal was however incomplete, the shape, and the relations of mouth and pharynx did not appear normal, and the gills ceased, even as tubercles, after the twenty-first segment; it seems not improbable, therefore, that this animal had only recently been separated, and had still to undergo a certain amount of development at this anterior end. The seventh specimen had no prebranchial setae, and setae were also absent on the first gill-bearing segment (pl. xi, fig. 3); the prostomium, mouth, pharynx and cerebral ganglion were well formed, and the animal had probably therefore been separated for a considerable time.

It is perhaps worthy of remark that in the fifth and seventh of the above specimens the prebranchial region seemed to present a somewhat indefinite, thicker or denser appearance of the tissues and a consequent slight opacity, as compared with the segments behind it. Whether this is of any importance or not is perhaps doubtful; but it reminded me of a similar somewhat denser and more opaque appearance of the tissues which is seen at the hinder end, in any of the Naididae, in the region where new segments are forming but not yet differentiated.

It is evident, in any case, that the distribution of setae in the anterior part of the body varies very considerably. So far as I am aware, such marked variations have not been noticed in any other form. Further remarks on the import of this variability will be found below.

Other anatomical features. In sections through the middle of the body, the sides of the animal are seen, in these specimens, to be somewhat pinched in; and at the level of each septum a distinct band of muscular fibres passes on each side from the lateral line to the gut; it is presumably the contraction of these fibres that causes the constriction referred to.

The pigment cells, as seen in sections, are large irregular cells, containing a large number of brown granules, and indeed appearing to be made up of them (pl. xi, figs. 5, 6). The cells occur in several situations,—(a) round the dorsal vessel and lateral commissures, (b) along the muscular fibres passing through the coelom from gut to parietes, (c) inside the muscular layer of the body-wall, (d) apparently more or less free, as corpuscles inside the body-cavity, attached however to the inner surface of the parietes by processes of the pigment cells themselves, or of other corpuscles.

The buccal cavity is tubular, and is succeeded by the pharynx, a portion of the tube which possesses a strongly ciliated and laterally extended dorsal diverticulum, the cells lining which are markedly columnar; while the ventral wall of the pharynx is composed of flatter and more irregular cells (pl. xi, fig. 5). The pharynx extends backwards to include the first gilled segment; the diverticulum then flattens out and disappears. The oesophagus is strongly ciliated; there is no stomach,—indeed, beyond the pharynx, the tube can scarcely be differentiated into distinct regions.

The dorsal vessel is, for by far the greater part of its extent, dorsal in name only; it runs for the most part on the left of the intestine (pl. xi, figs. 2, 6); it is invested by chloragogen cells and pigment cells as far forward as the interval between first and second gills; here it becomes dorsal, and loses its investment.

The present species does not stand alone in the matter of the aberrant course of the dorsal vessel. I have ascertained, from an examination of my specimens, that *B. hortensis* is similar in this respect, though the fact was not noted in my original account of this worm. It is known also to be the case in the various species of the genus *Dero* (Naididae), and in *Branchiura sowerbyi* (Tubificidae) (1, 13); and I have found it also in the Tubificid worm I have described (13) as *Limnodrilus socialis*. One peculiarity common to all these forms is that they possess specialized respiratory arrangements; *Dero*, *Branchiura*, and *Branchiodrilus* possess branchiae, while *Limnodrilus socialis* has a well-developed integumentary blood plexus in the posterior part of its body, and during life is incessantly waving this posterior end in the water; but as to what connection there is between such specialized respiratory arrangements and a lateral or ventrolateral position of the dorsal vessel I am not clear.

There is a large giant fibre on the dorsal surface of the ventral cord, looking in sections like a large empty tube (pl. xi, fig. 6).

(2) *Asexual Reproduction.*

One specimen only was dividing asexually (pl. xi, fig. 4); and here a fragment only of the posterior animal was present. The whole specimen consists of 87 segments in the anterior animal, and nine segments of the posterior. Though apparently nearly ready for detachment, there is as yet no differentiation of a head in the hinder zooid, no mouth, and no new setae, no newly formed segments, nor any region intervening between the first gilled segment and the anterior end of the body: the gills however have formed, and the characteristic pigmentation of the anterior region is beginning to appear. At the posterior end of the anterior animal there is an appearance suggestive of the approaching rapid formation of a budding zone,—a slight opacity, and an irregular fine transverse streaking, more especially on the ventral half of the body.

The condition is therefore to be compared with what occurs in Bourne's *Chaetobranchus*, where there is no budding zone, and the process of division resembles rather a simple fission of the animal into two. It is to be contrasted in this respect with the species I found at Lahore, where a regular budding zone is formed, as in *Nais*, *Chaetogaster*, etc. Further, the present form agrees with Bourne's in the fact that asexual reproduction is apparently a comparatively rare occurrence; Bourne, out of a large number, found only a few specimens dividing; whereas in many species of Naididae it seems to be rather the exception than the rule to find an animal which is not preparing to divide.

It would appear from the specimen undergoing division (pl. xi, fig. 4),—if I am right in supposing that a separation of the two individuals was here not far off,—that a considerable amount of the development of the head has still to be gone through after fission is completed. This is confirmed by the actual condition of two of the free-living specimens examined (the fourth and sixth; cf. *ant.*, under the description of the prebranchial region).

Can this inference be used to explain the remarkable variations in the distribution of the prebranchial setae? In other words, can we suppose that all specimens which show fewer than four pairs of ventral setal bundles in front of the gills have recently been separated, and have not yet completed the development of the anterior end,—and that the production of the full number of setal bundles will follow in time? Would the specimens described above have developed, in all cases, four bundles of ventral setae in the prebranchial region if they had been left alive?

This seems quite possible with regard to such specimens as the fourth and sixth of the foregoing description; here the other structures of the anterior end—prostomium etc.—were also incomplete, and it is quite possible that the setae might, later, have developed along with these.

It does not seem very probable with regard to some of the other specimens. For example, in that represented in pl. xi, fig. 3, the seventh of the previous description, the prostomium, mouth, and other features of the anterior end are well developed, yet the ventral setae are wanting; had they been going to develop, there would have been at least some signs of them. The same may be said with regard to the fifth. And in the specimen with three well-developed setal bundles in the prebranchial region (pl. xi, fig. 2) there would probably have been some sign of a fourth if a fourth had ever been going to develop. Again, asexual reproduction apparently here, as in Bourne's worm, does not occur with any great frequency; hence the chances are very much against six out of these seven specimens having been very recently separated, as the above explanation would demand.

The matter may therefore be summed up as follows: In the present form the process of asexual reproduction is accompanied by the formation of only the rudiment of a budding zone; separation of the two resulting individuals takes place early;

and a considerable portion of the process of differentiation of the head is completed after separation. In this differentiation, the formation of the setal bundles sometimes lags behind that of the other structures, and the number of setal bundles formed varies considerably. Not infrequently, it would appear, none are formed; and the maximum number of four is perhaps comparatively seldom produced.

(3) *Systematic Position.*

Though closely related to the worm which I have described as *Lahoria hortensis*, the present species is not identical with it; and the more restricted distribution of the gills in the form under discussion, the details of asexual reproduction, certain differences in the form of the setae, and the smaller number of these in both dorsal and ventral bundles, are sufficient to distinguish it.

With regard to Bourne's *Chaetobranchus semperi* the agreement is in many respects closer. Thus Bourne gives identically the same number of segments (130) which I counted in the best developed specimens of the present batch; the details of pigmentation correspond in the two; the number and distribution of the gills is about the same; the details of asexual reproduction are strikingly similar, and different from what is usual in other Naididae; and finally both were taken in the same locality.

On the other hand there are several points of difference. To begin with the less important, the length of Bourne's worm appears to have been greater, though some of the apparent difference is no doubt due to contraction of the preserved specimens; the setae did not begin to project freely so soon in Bourne's specimens (about the 30th segment), as in mine (13th to 28th); and, to judge from Bourne's figure, the position of the mouth is different in the two, the prostomium being considerably longer, and the prebranchial region somewhat shorter in Bourne's specimens than in those now under discussion. Further and more important differences are found in the characters of the setae; though those of the two forms have a general resemblance, this does not extend to details (compare, for example, the dorsal needles of the present form with the sickle-shaped dorsal setae of *Chaetobranchus semperi*); and a marked distinction is found in the numbers of setae per bundle, both in the dorsal and ventral series. Lastly there is the fact that in the present form there may be as many as four pairs of ventral setal bundles between the first gills and the mouth.

In my present specimens, it is only in a minority that well-formed setal bundles are developed between the first gills and the mouth; and had I received a smaller number of the worms, say two or three only, it is not improbable that such examples would have been wanting altogether; in which case, in view of the many and detailed points of similarity, it is not unlikely that I should have recorded the present find as a rediscovery

of Bourne's worm. It does not seem possible, on the other hand, that Bourne should have overlooked the occasional occurrence of prebranchial ventral setae, since he "secured numerous specimens of *Chaetobranchus*" and (with regard to the mode of asexual reproduction at least) "examined a very large number of individuals."

The two forms are therefore to be regarded as distinct, and I accordingly propose for the one herein described the specific name *menoni*. It seems however impossible, merely on the ground of a (far from constant) difference with regard to the prebranchial setae, to deny a close genetic relationship between the two. They must undoubtedly be regarded as belonging to the same genus.

For the generic name *Chaetobranchus*, which, since it is the name which Bourne used, has been employed above in referring to the worm described by him, Michaelsen (8) substituted *Branchiodrilus*, *Chaetobranchus* having been previously used for a fish. The new worm thus becomes *Branchiodrilus menoni*.

If however these two species are ranked under the same genus, so must be the form from Lahore described by me as *Lahoria hortensis* (15); since the reason for separating this latter as a distinct genus from Bourne's worm was the same difference with regard to the prebranchial setae which occurs or may occur in *B. menoni*; i.e. the fact that four (or three) pairs of ventral setal bundles may occur in front of the first gills, or rather (which comes to the same thing) in front of the first dorsal setae.

The genus therefore now comprises three species, and genus and species will be defined as follows:—

BRACHIODRILUS Mchlsn. (= *Chaetobranchus* -Bourne):

Prostomium rounded. A pair of dorso-laterally placed branchial processes on many or most of the body-segments, beginning immediately or a short distance behind the mouth. Ventral setae crotchet shaped, forked distally. Dorsal setae beginning in the same segment as the gills, of two kinds, capillary and needles; the former, in a number of the anterior segments, enclosed in the gills.

1. B. semperi (Bourne).

Length 38-50 mm., diam. ·5 mm., segments 130. Branchial processes begin in the segment behind the mouth; at first are about four times as long as the diameter of the body, then decreasing in length and disappearing at the 60th -70th segment. Dorsal setal bundles consist of two or three capillary setae, longer in the anterior, shorter in the posterior segments, and two or three short sickle-shaped setae, the latter wanting in the anterior segments. Capillary setae of dorsal bundles all enclosed in the branchial processes in about the first 30 segments, some so enclosed in about the next 30, thenceforward all free. Ventral

bundles of 4-6 setae, the distal prong of which is the longer in the most anterior segments, the proximal being the longer in the remaining segments. No stomach. Lymph corpuscles rounded, with numerous olive-green granules. Asexual reproduction without the previous formation of a budding zone.

2. **B. menoni** sp. nov.

Length (preserved) 8-15 mm., segments up to 130. A short prebranchial region between first gills and mouth, which may or may not possess a series of pairs of ventral setal bundles (up to 4 pairs). Gills diminishing in size posteriorly, and ending some distance in front of hinder end; longest gills $2\frac{1}{2}$ times as long as diameter of body. Dorsal setal bundles anteriorly of one or two hair setae; in the middle and posterior parts of the body of one hair and one needle seta, the latter somewhat bayonet-shaped, tapering to a fine point. The hair setae of the anterior bundles enclosed in the gills; becoming free before the 30th segment Ventral bundles usually of 3, sometimes of 2, setae; anteriorly slenderer, distal prong longer, nodulus proximal to middle of shaft or about its centre; further back the setae are stouter, distal prong approximately equal to or a little longer than proximal, nodulus distal to middle. No stomach. Asexual reproduction without or almost without previous formation of a budding zone.

3. **B. hortensis** (Stephenson) (= *Lahoria hortensis*).

Length 16-25 mm., diam. ·5-·75 mm., segments 90-120. Gills and dorsal setae begin on sixth (occasionally fifth) segment. Gills diminishing in size posteriorly, ending just in front of hinder end of animal; longest gills 3-4 times as long as diameter of body. Dorsal setal bundles of capillary and needle setae, not more than two of each per bundle; contained within the gills for the first 40--50 segments, then one hair seta of each bundle free; needle setae straight, pointed. Ventral bundles of 4-5 setae, distal prong slightly longer than proximal, and much thinner at its base. No stomach. A budding zone formed during asexual division.

4. *On Cephalization in the Naididae.*

Cephalization means the formation of a head; to quote from Beddard (2), "Lankester has applied this expression to the specialization of the anterior region of the body so frequently seen among the Oligochaeta." This specialization shows itself perhaps most prominently in the distribution of the setae;—"all Oligochaeta show cephalization as regards the first segment of the body, which never possesses setae." The Naididae which (except *Chaetogaster*) have regularly ventral setae in all segments from the second onwards, frequently lack dorsal setae in a number of the anterior segments, and there are thus in these cases

a number (usually four, i.e. segments ii—v) of segments which have ventral but no dorsal setae. It is frequently found moreover, e.g. in the genus *Nais*, that the ventral setae of these 'cephalized' segments are different in type from the succeeding ones; thus the distal of the two prongs of the forked end may be relatively longer, and the nodulus situated proximal, instead of distal, to the middle of the shaft.

Other systems or organs are concerned. Beddard instances septa and nephridia, which may be absent from the anterior segments. In addition I may adduce pigmentation; the cephalized segments may be lighter in colour, or the pigment may be differently arranged, as compared with the following segments. Chloragogen cells are absent from the alimentary tract in the cephalized segments. The gills of *Branchiodrilus hortensis* are similarly absent from this region.

The next point which I wish to bring forward is that this cephalization is related in the Naididae to the manner of asexual division, and to the production, between two separating individuals, of a budding zone. When one of the Naididae divides asexually, the usual procedure is that at some spot near the middle of the length of the animal a rapid production of new segments takes place; of these segments the larger number go to form the tail end of the anterior, the smaller number to form the head of the posterior, of the two resulting animals. This head commonly consists of five segments, with a prostomium, all newly formed; i.e., it corresponds to the number of cephalized segments as determined by the examination of free-living specimens. In other words these segments, produced in the budding zone, and representing the head of the (subsequently to be detached) animal, want the dorsal setae, and frequently have the ventral setae modified; they are commonly, at first at least, less pigmented (as are also the newly formed segments at the posterior end of the anterior animal); they contain no chloragogen cells, have no nephridia, and in *Branchiodrilus hortensis* are without gills.

Since the predominant mode of reproduction in the Naididae is the asexual, by fission,—sexual reproduction being a comparatively, or absolutely, rare occurrence,—by far the larger number of individuals of a species existing at any time will have been produced asexually, and *the cephalized segments will be those which have been produced in a zone of budding.*[1]

[1] This point with regard to the budding zone has not apparently received much attention from students of the Naididae and (in the somewhat scanty literature at my disposal) I cannot find any references as to how many of the segments produced in the budding zone go to the anterior end of the posterior animal in the different genera. My own observations on the genera *Chaetogaster*, *Nais*, *Slavina*, *Stylaria*, *Aulophorus* and *Branchiodrilus* show that the rule just stated holds for these (in *Chaetogaster*, where there are no dorsal setae, cephalization is marked by the regular series of ventral setae beginning only in the sixth segment), and it apparently holds also for *Aeolosoma* (fam. Aeolosomatidae), where the process is similar. It is to be noted however that *Pristina* is a remarkable exception; here no fewer than seven of the anterior segments are formed in the budding zone, though dorsal setae begin on the second segment and cephalization is therefore confined to the first.

From this it follows, that variations or irregularities in the process of budding will give rise to corresponding variations or irregularities in the degree and form of cephalization.

That the budding zone varies in position has been known for some time. It is usual, following Bourne (5), to denote by *n* the number of segments of the original animal behind which the budding zone appears, and though Bourne thought at first that *n* would be found to be constant for each species, it now appears that in a large number of species at least it varies within somewhat wide limits (for examples, *cf.* Benham (3), Piguet (11), Stephenson (16) (*Stylaria lacustris*)).[1]

Variations in position of the budding zone would not necessarily affect the number of cephalized segments ; the point has been mentioned, because variations in one respect prepare us to look for variations in other respects. Such have been noted in *Nais communis* by Piguet (11) :—" à diverses reprises, j'ai trouvé un certain nombre d'exemplaires qui n'avaient que 4 segments avant celui où débutent les soies dorsales et les cellules chloragogénes (normalement, le 6me). J'ai d'abord pensé à une régénération incomplète après mutilation ; mais tous ces individus avaient la région antèrieure absolument normale. sauf que leur 5me segment étail l'homologue du 6me des autres. Il faut donc supposer que le bourgeonnement produit quelquefois, accidentellement peut-être, des spécimens ayant, dans la region du pharynx et de l'oesophage, un segment de moins que les autres.'' The fact that in *Branchiodrilus hortensis* there may be either four or five cephalized segments (15) belongs here also. And in *Slavina punjabensis* I found (14) a number of irregularities in the results of the budding process ;—incomplete differentiation of the head, an eye wanting on one side, fewer setal bundles, and these containing fewer setae than normal ;—which might perhaps be partly explained by supposing that separation of the two individuals had taken place before the differentiation of the head had been completed, and that this differentiation would follow after, instead of as usual coming before, the separation. But it is perhaps equally likely that these irregularities were destined to endure.

This brings us to the condition in *B. menoni.* We have here before us a number of variations in the characters of the anterior end of the animal, especially in the numbers of the ventral setal bundles in front of the gills (or of the first dorsal setae). As to how this is related to the process of asexual reproduction, and how far these variations may be due merely to a delayed differentiation of the newly formed head, see the section on Asexual Reproduction. Referring to the discussion there for support, it will be sufficient now to state that *in* B. menoni *we have a species which varies within wide limits in regard to cephalization, as manifested especially in the setal distribution.*

[1] In the Aeolosomatidae however and in the genus *Chaetogaster*, in which cases the number of body segments is small, *n* would seem to be fixed for each species, according to observations on all the species that have come under my notice.

The importance of a right estimate of the value of cephalization, as marked by the want of correspondence in the anterior limits of the dorsal and ventral setae, is apparent when we call to mind that this is one of the characters by which the genera of the Naididae are discriminated. Thus the segment on which the dorsal setae begin (reckoning the first segment with ventral setae as the second of the animal's body) figures as a diagnostic mark of genera in Vejdovsky (17, p. 25), and in Michaelsen (8, p. 17). The extent anteriorly of the dorsal setae is the chief, if not the only, distinction between the genera *Naidium* and *Nais*. To quote from a former paper (15) :—"Beddard (2, p. 281), merging together a number of genera of other authors under the one name *Nais*, does so largely because they 'agree in the important fact that the first five segments are cephalized,—that the dorsal setae do not commence until the sixth segment,' and by implication would exclude from the genus any form which did not show this cephalization. Similarly *Pristina* and *Naidium* are united by him on the ground of the absence of this feature. Bourne (5) also believed that the number of cephalized segments is constant for the genus, and thought it probable that *Dero furcata*, possessing four achaetous dorsal segments, should on this account be removed from the genus, since the other members of it have five such segments." And specially with regard to *Branchiodrilus*, "the presence of dorsal setae on all segments from the second onwards is mentioned as a feature in the generic diagnosis of *Branchiodrilus* in Bourne's original paper (4), in Beddard's monograph of the Oligochaeta (2), and by Michaelsen (8)."

It is therefore evident that a distinction such as that which obtains between *Branchiodrilus semperi* and *B. hortensis*, where the dorsal setae begin on the second and sixth segments respectively, is held by most authorities as a ground for a generic separation. Holding this view myself, I accordingly separated the Lahore species as a distinct genus, *Lahoria*, though I thought it "perhaps worth while asking whether a cephalization which affects only the setal distribution (for the absence of gills on segments ii—v of the present form [i.e. *B. hortensis*] is evidently correlated with the absence of the setae which are necessary to stiffen them) has the systematic value hitherto generally attributed to it."

It is to be added that the above view, of the absolute value of a different anterior extent of the dorsal setae as a generic character, has not always been strictly maintained. Thus Michaelsen (8) unites into one genus *Paranais* three species known at various times as *Naidium naidina*, *Paranais littoralis*, and *Uncinais uncinata*, though their dorsal setae begin respectively on the second, fifth, and sixth segments. And in a recent paper (9) the same author prefers to include my *Lahoria hortensis* as a species of *Branchiodrilus* (as I do in the present paper), allowing the numerous close structural resemblances to over-ride the somewhat artificial distinction based on the distribution of the dorsal setae.

With the discovery of *B. menoni* the case becomes stronger. I was in doubt at first as to whether it would not be advisable to unite it with Bourne's worm under the same species, *B. semperi*; since the points of structural agreement are many, and in some cases extend into detail; and there can at least be little doubt of a close genetic connection. Yet, allowing the usual value to cephalization, the difference between some specimens of *B. menoni* and *B. semperi* would be generic; and indeed the same might be said of specimens of *B. menoni* alone, when compared one with another.

The conclusion to be drawn is that *the degree of cephalization in the Naididae is correlated with the behaviour of the segments of the budding zone,*[1] *and that variations in both, of considerable extent, may occur within the same species. The form of cephalization which is characterized by the absence of dorsal setae from a number of the anterior segments of the body has been evolved repeatedly, in different groups of the Naididae, and at different times. The degree of cephalization is not necessarily a generic character, since differing degrees of cephalization may coexist with a remarkable similarity in general organization.*

One point of a more speculative nature remains. In the case of *Branchiodrilus hortensis*, which usually has five prebranchial segments, specimens are occasionally met with which possess only four such segments; in these cases the first gilled segment would seem to be homologous throughout, i.e. the sixth segment of some individuals is homologous with the fifth of others. Similarly, according to Piguet, in *Nais communis* (v. *ant.*) :—"mais tous ces individus (i.e. those with only four segments in front of that on which the dorsal setae began) avaient la région antérieure absolument normale, sauf que leur 5me segment était l'homologue du 6me des autres."

Similar considerations must be extended to *Branchiodrilus menoni*; the first gilled segment is homologous, throughout the individuals of the species, though these individuals vary as regards the number of segments intercalated in front of this fixed point and behind the mouth.

But while some specimens of *B. menoni* agree in the arrangement of their segments (as determined by the setal bundles) with *B. semperi*, others agree with *B. hortensis*. It follows that the first gilled segment is homologous in these two species, i.e. segment vi of *B. hortensis* is homologous with segment ii of *B. semperi*.

If this is the case, then we must infer that the same holds generally in the Naididae, and that the segment immediately succeeding those produced in the budding zone,—usually, but not always, that on which the dorsal setae begin,—is homologous thoughout the group.

[1] Compare however what was said previously (footnote p. 230) regarding *Pristina*.

As to whether this would lead to difficulties with regard to the homologies of the genital organs or not I cannot say. It would be interesting to have details of the budding process and of the position of the genital organs in *Naidium*, where the dorsal setae begin on the second segment; but these are lacking. The above views would not lead to any difficulties in the case of *Pristina*: here the testes are in segment vii, the ovaries in viii, i.e. the genital organs are displaced two segments backwards as compared with other genera. But the segments contributed to the animal's head from the budding zone are also more numerous than usual, seven instead of five, and therefore the testes are still in the last segment to be added from the budding zone, as in *Nais* and other genera.

II.

Branchiura sowerbyi, Bedd.

This interesting worm, belonging to that small group of Oligochaeta which possess gills, was first described by Beddard (1) in 1892 from specimens obtained from the mud of the *Victoria regia* tank in the Royal Botanical Society's Gardens in London; of these specimens only one was sexually mature, and this furnished the material for his description of the genital organs. No more was heard of this worm till 1908, when Michaelsen (7) found specimens, among them several sexually mature, in a warm water tank of the Botanical Gardens at Hamburg: Michaelsen's account deals exclusively with the genital system, in which he finds a number of differences as compared with Beddard's description. L. Perrier (10) shortly afterwards notified the discovery of numerous specimens in the Rhone, but did not add any anatomical details. Lastly in 1911 I (13) found the worm in a nullah near Lahore in the Panjab; I was able to add a number of anatomical facts to those recorded by Beddard, but none of my specimens were sexually mature.

I have since then received specimens from two sources. In May 1911 Mr. Gravely of the Indian Museum sent me a tube containing living specimens of the worm taken in Calcutta: they were obtained from mud in an earthenware basin containing aquatic plants planted in mud and water in the Museum garden. It is noteworthy that the worms were put into the tube on the 12th May, and were received by post in Lahore at 4.30 p.m. on the evening of the 15th; the tube was opened immediately, and the worms were found to be still quite lively. The mean temperature at Lahore for the 24 hours was at this date 90°, the maximum in the shade 106° F, and the temperatures must certainly have been higher in a railway van coming from the south.

A few observations were made on the movements of the living worm. As remarked above, they were quite active. The posterior part of the body was at times held quite still while the

anterior part was wriggling; the movements of the posterior parts when these occurred, were either irregular wrigglings or regular undulating movements. The gills in these specimens showed no movements of their own when the tail was at rest. The worms manifested a sharp and sudden response to a touch with a needle; they contracted somewhat, and then as a rule remained quite motionless for a short time, subsequently resuming their movements.

As to their external characters, the gill region was short; in one case well developed gills ceased suddenly a little distance in front of the hinder end, and behind this point there were only tubercles,—about a dozen in both dorsal and ventral series, the two or three most posterior being slightly larger than the rest; this peculiarity was possibly due to previous injury. On holding the tube up to the light and looking through it the gills were invisible to the naked eye in the living animal on account of their transparency: their length was not greater than the diameter of the body. The length of the animals was from 1¾ to 2 inches when extended, and their breadth 1 mm. or more. One specimen exhibited genital organs, as described below.

Again in November 1911 I received from the Indian Museum a tube of these worms, preserved, which had been taken in Madras in the mud from the *Victoria regia* tank in the Agri-horticultural Society's gardens, in September-October, 1907, by Prof. K. Ramunni Menon. The specimens were in a bad state of preservation, and consisted of 18 fragments, of sizes from 25 to 2 mm., mostly small; these had apparently belonged originally to two worms, of which neither showed sexual organs. The peculiarity about these specimens was that they were constricted, in transverse section, so as to show a somewhat figure-of-eight appearance: but the dorsal, and still more the ventral, surface was flattened, the ventral surface, in the region in front of the gills, giving the appearance of a flat sole.

The occurrence of a sexual specimen among the worms received from Calcutta offers the opportunity of adding a few remarks on the genital organs. The differences between the descriptions given by Beddard and by Michaelsen are very considerable. As briefly as possible, the chief of these are as follows: Michaelsen finds that the vas deferens enters the proximal expanded portion of the atrium very obliquely through the wall of the latter, nearly but not quite at its rounded extremity; this portion of the atrium is lined by long columnar epithelium, surrounded by a voluminous investment of glandular cells, and encroaches posteriorly, where the vas deferens joins it, on segment xii. It merges anteriorly into the middle region of the atrium, which is narrower, undergoes several irregular windings, and before becoming the distal region of the atrium is joined by the paratrium. The distal region of the atrium is again wider, is bent at its upper end like a hook, but its main portion passes vertically downwards to the male aperture. The paratrium is a long

diverticulum from the middle region of the atrium, closely bound up with the atrium for some distance near its origin, then separating from it though still running parallel; it extends back through the whole extent of segment xii, has an insignificant lumen, and is, like the proximal portion of the atrium, covered with a thick layer of glandular cells. A special ovoid coelomic sac encloses the distal section of the atrium and so much of its middle section and of the paratrium as are bound up together. The spermathecae consist of a duct with an expanded spherical ampulla.

Beddard on the other hand shows the vas deferens as joining the atrium about the middle of the length of the latter. The internal half of the atrium has thus the appearance of being a diverticulum of the male efferent canal; it is a large ovoid sac, with a considerable lumen and a voluminous investment of gland cells of peritoneal origin. The distal half of the atrium, below the junction of the vas deferens, is tubular, and is surrounded by a considerable muscular investment. The spermathecae are pear-shaped.

The differences briefly indicated above might possibly be explained, according to Michaelsen, in one or more of three ways. First, Beddard's specimen might not have been fully mature; but this explanation is in any case not by itself sufficient, and moreover the clitellum was well developed in Beddard's specimen, and the spermathecae contained spermatozoa. Or Beddard may have been misled, owing to the scantiness of his material, and the difficulty of working out a complete description from one specimen only; in this case it may have happened that Beddard has overlooked the paratrium, and mistaken the relation of vas deferens to atrium. Lastly, the specimens of the two observers may have belonged to different species; this however Michaelsen thinks very unlikely, since if the above differences do actually exist they are not of specific but of generic importance.

The sexual specimen from Calcutta, mentioned above, was pretty certainly not fully mature; in the sections, ripe spermatozoa are indeed seen entering the seminal funnel, and the sperm sac extends as far backwards as segment xiv; but the clitellum is indistinguishable, the spermathecae contain no spermatozoa, and there is no ovisac with contained ova. But in the circumstances above mentioned, the examination of other sexual specimens of this worm is a matter of some interest and importance; and the present specimen has probably this advantage, that it will at least indicate whether the differences in the two already published accounts are or are not due to the first of Michaelsen's suppositions, i.e. to Beddard's having worked on an immature specimen.

Briefly, the Calcutta specimen agrees with Michaelsen's description in all essential points; and a full account would therefore be quite superfluous. It will only be necessary to refer to the figures appended, and to mention the characters in which the present specimen differs from Michaelsen's account.

(i) The atrium and paratrium are confined to segment xi, and do not encroach on xii.

(ii) The proximal part of the atrium is a spherical sac, sharply marked off from the middle portion, and lined by cubical, not columnar, epithelium (pl. xii, figs. 1, 4).

(iii) There is no bulky covering of gland cells surrounding either atrium or paratrium (pl. xii, figs. 1–4).

(iv) The lower portion of the paratrium runs side by side with the middle region of the atrium in a common sheath (pl. xii, fig. 2), as in Michaelsen's specimens, but their lumina never unite, and open separately into the distal section of the atrium (pl. xii, fig. 3).

(v) The combined atrium and paratrium undergo fewer windings in the coelomic sac than is described by Michaelsen.

(vi) The distal section of the atrium is straight throughout, not hooked at its dorsal extremity (pl. xii, fig. 5).

(vii) The spermathecae are small, egg-shaped, with thick walls and small lumen.

(viii) The female efferent apparatus is not described by Michaelsen Beddard describes an oviduct opening on the furrow between segments xi and xii. I find an ovarian funnel on septum 11/12 (pl. xii, fig. 1), which leads to the exterior by a short oviduct opening on segment xii, a little distance behind the level of septum 11/12.

I think it probable that most, if not all, the differences between the Hamburg specimens and the present one are to be referred to their being in different stages of development. And since the present specimen is presumably at a less rather than a more advanced stage of development than that described by Beddard, and since nevertheless it shows a fairly close agreement with Michaelsen's description, it does not seem likely that the discrepancies in the accounts of Beddard and Michaelsen are due to differences in the degree of maturity of their respective specimens. The explanation of those discrepancies is therefore to be sought in one of the other directions indicated by Michaelsen.

III.

Limnodrilus socialis, Stephenson.

The above worm was recently described by me (13) from Lahore, where it is common. I have twice received specimens alive from Mr. Gravely of the Indian Museum; the first occasion was in March 1911, the worms having been taken in a masonry drain at Belgatchia near Calcutta, the second in May 1911, when a tube of these worms, taken within the precincts of the Museum, was received at the same time and under the same conditions as the *Branchiura sowerbyi* previously mentioned.

Since the shape of the cerebral ganglion is largely used for purposes of discrimination and identification, I append a sketch of it, from a specimen in which it was well seen (fig. 4).

IV.

Enchytraeus indicus, sp. nov.

I received from the Indian Museum in October last a small tube of worms collected by Mr. S. P. Agharkar, of the Elphinstone College, Bombay, in the neighbourhood of that city. Mr. Agharkar's note concerning the specimens is as follows:—"Oligochaete found in egg membranes of the common pond snail *Ampullaria*. They were found in the eggs of this snail which I collected on August 18th. The eggs were kept in a moist place for hatching, and on the 6th September, 1911, the young snails came out one by one. In some of these eggs, instead of the young snail, I found this worm. In other cases however it was found in the membrane surrounding the young snail."

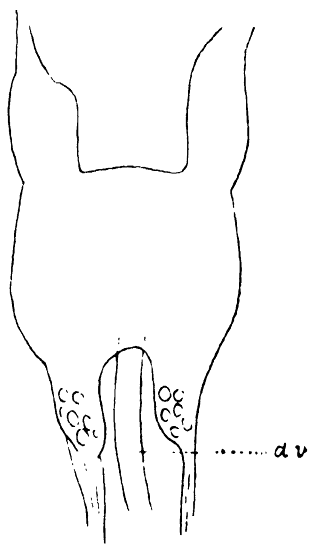

FIG. 4.—*Limnodrilus socialis*; cerebral ganglion, from above. *d.v.*, dorsal vessel.

The tube contained six specimens, of which one was very small, in a good state of preservation.

External characters.—The length was about 4 mm., the colour brownish, number of segments 31. The prostomium was short and bluntly conical; there was a head-pore between prostomium and first segment. The clitellum embraced segments xii—xiii; it was absent however from the median portion of the ventral surface of these segments.

The *setae* are of the type which is ordinarily found in the genus,—shaft straight with however a slight proximal curve, without nodulus, gently swollen towards the free extremity, and pointed at the end. In length they are approximately 50μ. The

ventral series are three per bundle in segments ii—xi, absent in xii and two per bundle behind this. The dorsal series are two per bundle throughout.

The *alimentary canal* begins in a tubular buccal cavity lined by low, approximately cubical, epithelium. The pharynx succeeds, and is in turn followed by the ciliated oesophagus, narrow as far as segment vi, a little wider in vii and viii ; its calibre finally increases in xiv where the tube becomes the intestine ; the cilia are specially long in segments vii—xi. Three pairs of septal glands are present, in segments iv, v and vi ; their position would perhaps be more accurately described by saying that they are in close connection with septa 4/5, 5/6 and 6/7, which split to enclose them ; the posterior pair of glands are united ventrally underneath the oesophagus. Peptonephridia are present as narrow coiled tubes in segment iv.

The *dorsal vessel* begins in segment xiii apparently, or at dissepiment 12/13. It divides just behind the level of the mouth : the two divisions unite again ventrally, probably in segment v, to form the ventral vessel.

The *nephridia* are of the compact type, with a small anteseptal portion and a pear-shaped postseptal ; the latter twice as long as the anteseptal, the broad end anterior, the narrow end continued into the duct, which passes downwards and backwards. The duct is about half as long as the postseptal portion, and duct and postseptal together are about twice as long as broad. The first nephridium is in segment v.

The *cerebral ganglion* is large, in segment ii, and has the dorsal vessel closely applied to it underneath. From sections it appears to be slightly convex behind, or at any rate not indented.

Reproductive organs.—The testes are in xi, attached to septum 10/11 ; there are no sperm-sacs. The funnels are in xi ; they are much smaller than is usual in the family, and do not diverge very greatly from the ordinary form ; thus there is a small open funnel-like mouth, which is succeeded by a portion of the tube composed of columnar, clear and mucous-looking cells (cf. pl. xii, fig. 6, drawn from a specimen in cedar oil). The vas deferens passes through septum 11/12, is coiled in the anterior part of segment xii, but straight in its posterior portion ; it is very narrow, its diameter being 7-8μ. The penial body, in the posterior part of xii, is spherical, has a diameter of 40-45μ, and opens on the surface by a wide aperture (pl. xii, fig. 6).

The ovary is attached to septum 11/12. Ova are found in all segments from viii to xii inclusive ; segment xii may be largely filled by them (pl. xii, fig. 6). The funnel is a backward depression of septum 12/13 on each side, at its ventral attachment to the body-wall, whence the short narrow oviduct leads directly to the exterior.

The spermathecae open to the exterior in the intersegmental groove 4/5 ; the ampulla of each is small, approximately spherical or ovoid, in diameter about 30μ ; it probably communicates with

the oesophagus, though my preparations do not show the actual opening. The duct is several times as long as the ampulla, and is bent once or twice in its course; in diameter it is 11-12μ.

I may add a few remarks on two of the above characters. The first is the penial body. The Enchytraeidae possess in general glandular structures surrounding the external end of the vas deferens, but differ among themselves in the disposition of the gland-cells; in some cases there are a number of separate aggregates of these cells, opening on the surface of the body around the male aperture, while in other cases the whole of the gland-cells are compacted into a spherical, ovoid, or reniform penial body, surrounding the last part of the vas deferens. Eisen (6) proposes this distinction as a means of separating the Enchytraeidae into two subfamilies, the Lumbricillinae which have, and the Enchytraeinae which have not, a penial body. I have shown however (12) that the representative genera of the subfamilies, *Lumbricillus* and *Enchytraeus*, are connected by a number of forms which have a more or less intermediate position; and that in particular a penial body occurs in more than one species of *Enchytraeus*. It is interesting to find that this is the case in the present species also.

The second point is the condition of the seminal funnel. Its general form in the Enchytraeidae is described by the word 'barrel-shaped,' and this form is occasioned by the excessive elongation of the cells composing the first part of the duct; at the same time the cells become clear and stain only slightly, due presumably to the formation within them of a mucous substance. In the present species the funnel is small, and the change in the cells comparatively slight; the condition is therefore intermediate between that usual in other families and that which is characteristic of the Enchytraeidae.

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PLATE XI.

Explanation of Figures.

FIG. 1. *Branchiodrilus menoni*; anterior end of a specimen with four ventral setal bundles in prebranchial region; no ventral setal bundle is to be made out in the segment of the first gill; the first gill has apparently been damaged; × 85.

FIG. 2. *Branchiodrilus menoni*; anterior end of a specimen with three ventral setal bundles in prebranchial region; the second gil lhas been damaged; the dorsal vessel is seen on the left side of the oesophagus; × 150.

FIG. 3. *Branchiodrilus menoni*; anterior end of a specimen with no ventral setae in prebranchial region; none could be seen in the first gilled segment either; × 85.

FIG. 4. *Branchiodrilus menoni*; a specimen in which asexual division is taking place, and is apparently nearly completed; × 68.

FIG. 5. *Branchiodrilus menoni*; transverse section of the prebranchial region, showing structure of pharynx and position of pigment cells. The specimen is that shown in fig. 1; × 150.

FIG. 6. *Branchiodrilus menoni*; transverse section through the sixth gill, showing position of blood-vessels, pigment cells, etc.; same specimen as fig. 4; × 150.

Alim., alimentary canal; *chl.*, chloragogen cells (much resembling pigment cells); *c. m.*, circular muscular layer; *d. v.*, dorsal vessel, *ep.*, surface epithelium; *g.*, gill; *l. v.* lateral commissural vessel; *l. m.*, longitudinal muscular layer; *pig.*, pigment cells in various situations; *ph.*, pharynx; *v. n. c.*, ventral nerve cord (the apparently empty space dorsal to it in fig. 6 is the giant fibre); *v. v.*, ventral vessel.

All the figures drawn with Zeiss's Abbe's drawing apparatus. The two sections (figs. 5 and 6) are seen from their front face; hence left and right are reversed.

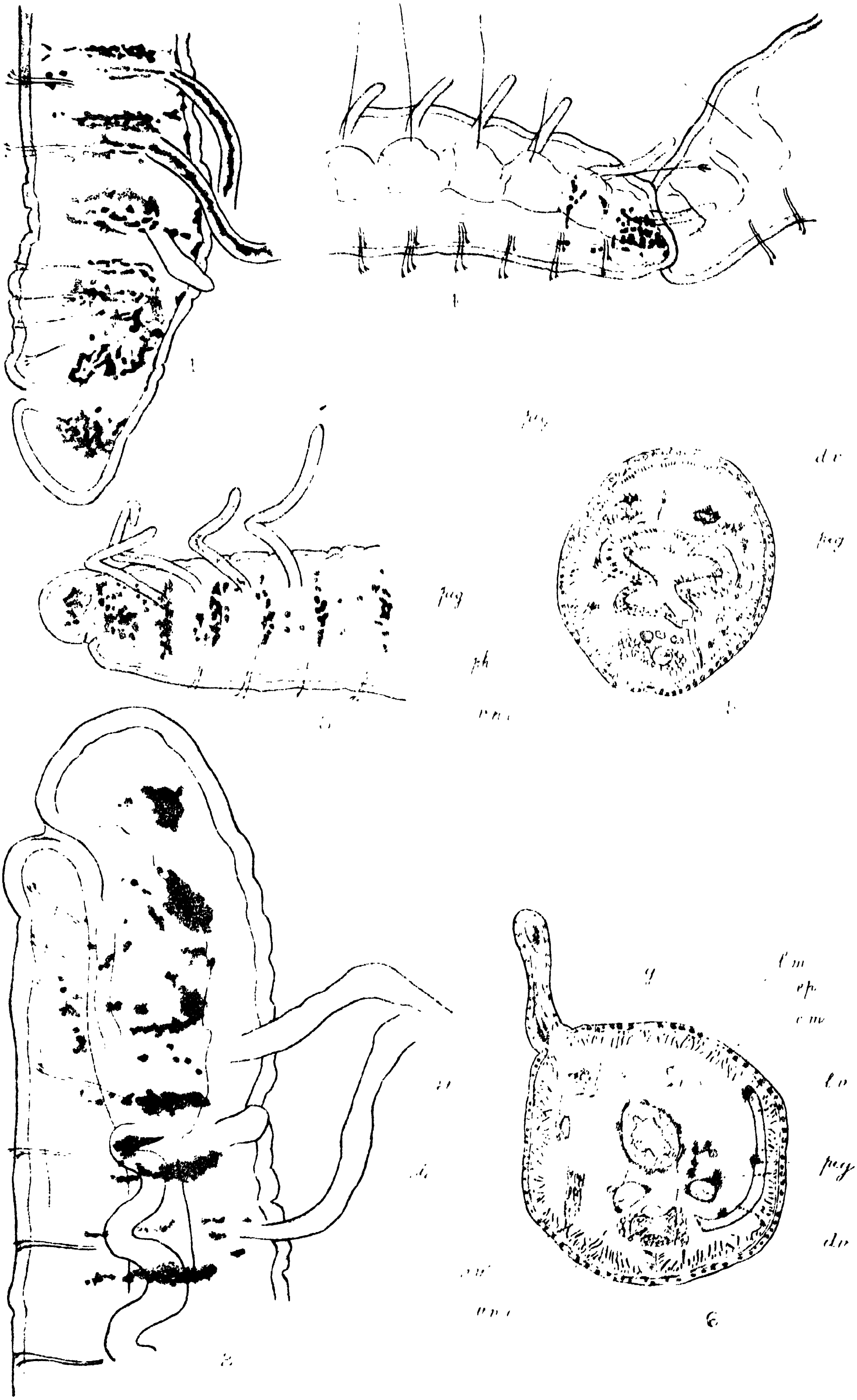


PLATE XII.

Explanation of Figures.

FIG. 1. ***Branchiura sowerbyi***; oblique section through posterior portion of segment **xi**; × 120.

FIG. 2. *Branchiura sowerbyi*; section through middle portion of atrium with paratrium; × 410.

FIG. 3. *Branchiura sowerbyi*; section through upper portion of coelomic sac, showing junction of paratrium and middle region of atrium with distal portion of atrium; × 330.

FIG. 4. *Branchiura sowerbyi*; section through proximal region of atrium and paratrium outside coelomic sac; × 240.

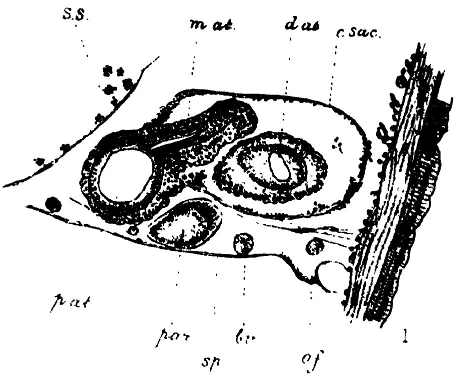
FIG. 5. *Branchiura sowerbyi*; vertical section through coelomic sac and distal region of atrium; × 95.

The above five figures drawn by Abbe's drawing apparatus from a series of longitudinal sections through the anterior end of a single specimen; the sections pass pretty accurately through the distal portion of the atrium on one side (fig. 5), but obliquely on the other (fig. 1).

B. v., blood-vessel; *c. sac.*, wall of coelomic sac; *d. at.*, distal portion of atrium; *d. w.*, dorsal body-wall; *m. at.*, middle portion of atrium; *o. f.*, ovarian funnel; *par.*, paratrium; *p. at.*, proximal portion of atrium; *per.*, peritoneal cells round proximal portion of atrium, corresponding to the glandular cells of other observers; *sp.*, septum 11/12; *s. s.*, sperm sac; *v. def.*, vas deferens; *v. w.*, ventral body-wall; *x*, at upper end of distal portion of atrium, indicates the place where, in a neighbouring section, the paratrium and middle portion of atrium enter: ♂ male aperture.

FIG. 6. *Enchytraeus indicus*; segments xi and xii, from a specimen mounted whole in cedar oil.

Clit., clitellum; *f.*, seminal funnel; *ov.*, ova; *pen.*, penial body; *s.*, seta; *t.*, testis.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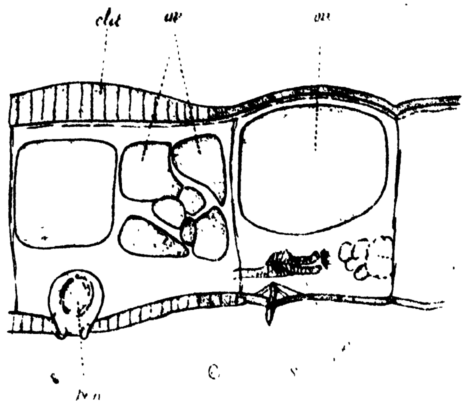
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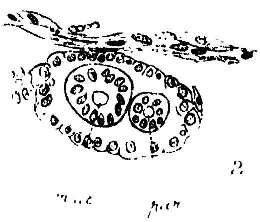
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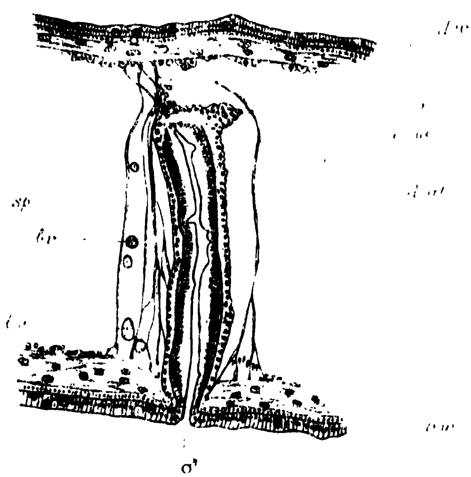
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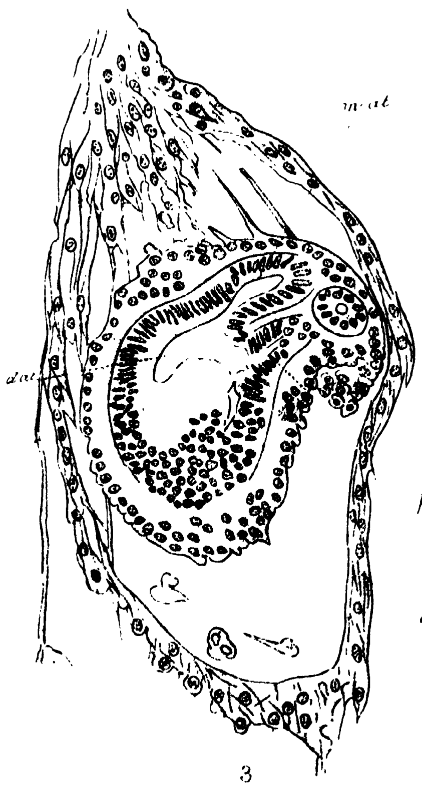
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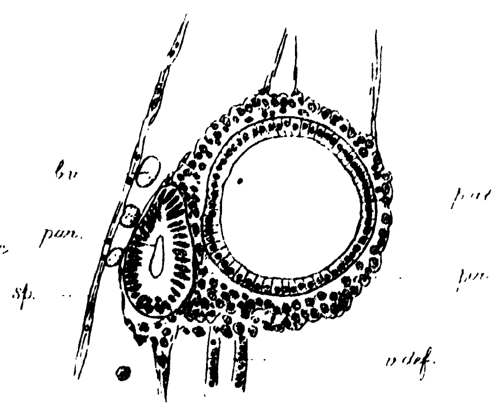
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XXII. FAUNA SYMBIOTICA INDICA.

No. 4.—*CARIDINICOLA*, A NEW TYPE OF TEMNOCEPHALOIDEA.

By N. ANNANDALE, *D.Sc., F.A.S.B., Superintendent of the Indian Museum.*

The object of the present note is to give a concise systematic description of an interesting symbiotic flatworm and to state what little is known of its habits. In preparing the description I have been indebted to the assistance of Mr. F. H Gravely, who will, I hope, publish before very long a detailed anatomical account of the Temnocephaloidea represented in the collection of the Indian Museum and will discuss the morphology of the species described below.

I. *SYSTEMATIC.*

Class TEMNOCEPHALOIDEA.

It is perhaps doubtful whether the members of the so-called class Temnocephaloidea are sufficiently distinct from the Trematoda to be given that rank, and the peculiar little worm discussed in this paper is in many respects intermediate between the two "classes." For the present, however, the recognized classification may be accepted as convenient.

The Temnocephaloidea or Temnocephala, whatever their precise rank, are small parasitic flatworms with tentacles at the anterior end of the body and a large ventral sucker at the posterior extremity. They have a capacious sack-shaped alimentary canal with an anterior mouth but without a posterior aperture. The external surface is clothed with a delicate chitinous cuticle but in some cases bears cilia on certain parts of the body. Immediately below the cuticle there is a definite epidermis, in which, however, cell-walls do not occur. The genital organs lie behind or on the ventral surface of the alimentary canal in the posterior part of the body; the genital pore is situated near the posterior extremity or in the middle of the ventral surface.

A single species (*Scutariella didactyla*)[1] has been found in Europe but the group as a whole is characteristic of tropical and subtropical, or at any rate southern countries. It apparently has its headquarters in Australia, but is also found in New Zealand, in Malaysia and in S. America. Only one Indian species [Wood-Mason (12)] has hitherto been identified,[2] namely *Temnocephala semperi*, Weber, which is common on freshwater

[1] Mrázek, *Sitz. K. Böhm. Gesellsch. Wiss. Prag* 1907, p. 1, pl.
[2] Mr. Gravely has recently identified specimens after comparison with some of Prof. Max Weber's original examples from Java.

crabs of the genus *Potamon* (especially *P. manii*, Rathbun) in hill-streams in parts of Tenasserim.

The Temnocephaloidea appear to be confined to fresh water and to live, without exception, symbiotic rather than parasitic lives. In habits they are predaceous, but they invariably attach themselves to a host which they can conveniently employ as a beast of burden and a stalking-horse in the pursuit of their prey. Each species affects a single host or a group of closely allied hosts. Most of the Temnocephaloidea are found attached to Decapod Crustacea; the Australian species inhabit the gill-chamber of crayfish; the Malayo-Burman *Temnocephala semperi* lives on the ventral surface of crabs; one S. American form attaches itself to equatic tortoises, while another penetrates within the pulmonary chamber of the Gastropod *Ampullaria*. The species to be discussed in this paper, like the allied European form, is associated with small prawns of the family Atyidae.

The Temnocephaloidea may conveniently be divided into three families as follows:—

I. At least four anterior tentacles; posterior sucker circular; alimentary canal much shorter than body, with the genital organs posterior to it.

A. No lateral tentacles; no anterior sucker; pulsatile excretory pouches present .. .. TEMNOCEPHALIDAE.

B. Lateral as well as anterior tentacles; an anterior sucker in front of the mouth; no pulsatile excretory pouches.. .. ACTINODACTYLELLIDAE.

II. Only two anterior tentacles, anterior margin of posterior sucker cleft; alimentary canal extending to posterior extremity, with the genital organs on its ventral surface; no pulsatile excretory pouches .. .. SCUTARIELLIDAE.

The third family appears to be considerably more remote from the two first than either of the latter is from the other, but it has not hitherto been recognized as distinct. It consists of two allied genera, *Scutariella*, Mrázek, and *Caridinicola*, gen. nov. The former is known from a single species from Montenegro: the latter from a single Indian species. The family may therefore be said to agree with most of the secondary divisions in the Temnocephaloidea in consisting almost of a minimum of forms. Only 5 genera (*Temnocephala*, *Craspedella*, *Actinodactylella*, *Scutariella* and *Caridinicola*) are known in the "Class" and of these *Temnocephala* is the only genus that is not monotypic, while the Temnocephalidae is the only family hitherto recognized that includes more than one genus, *Craspedella* as well as *Temnocephala* belonging to it.

Fam. SCUTARIELLIDAE, nov.

The two species included in this family are both minute, flattened, more or less ovoid or shield-shaped organisms associated with little freshwater prawns of the family Atyidae. They differ from all other known Temnocephaloidea in the following characters:—

(1) There are only two anterior tentacles, which differ in structure and function from those of *Temnocephala*.

(2) The posterior sucker is cleft anteriorly in such a way that it becomes either heart-shaped or horseshoe shaped.

(3) There are no external cilia on any part of the body.

(4) The alimentary canal extends backwards to the posterior extremity.

(5) The genital organs lie beneath instead of behind the alimentary canal and the genital pore is situated in the middle of the ventral surface.

In the absence of lateral tentacles the Scutariellidae agree with the Temnocephalidae but they resemble *Actinodactylella*, Maxwell (7, 8) in the absence of pulsating excretory pouches and in the arrangement of the genital organs. The external cuticle is minutely ringed.

CARIDINICOLA, gen. nov.

The mouth is almost precisely terminal and the whole pharynx can be extruded in the form of a proboscis. The tentacles arise on the dorsal surface, one on either side of the mouth At the base of each tentacle, on the ventral surface, there is a small sucker. The posterior sucker is horseshoe-shaped. The excretory system opens on either side by a pore on the lateral margin almost on a level with the eyes. There are two testes on either side, a larger and more conspicuous external and anterior testis and a smaller inner and internal one. The penis is armed with chitin and directed from right to left; the ovary resembles that of *Temnocephala* in structure and lies a little to the left of the middle line; the vitellarium does not cover the dorsal surface of the alimentary canal. Each tentacle has a large ganglion at its base An elongated gland runs along each side of the anterior part of the body towards the tip of the tentacle.

Type, *Caridinicola indica*, nov.

Distribution. -The Ganges and the Mahanaddi rivers, eastern India.[1]

CARIDINICOLA INDICA, sp. nov.

External characters. -The animal is highly contractile and almost protean in form, but is always flattened dorso-ventrally, more or less produced at the anterior end and truncate posteriorly.

[1] Since this was written Mr. Gravely has obtained specimens of *Caridinicola* on *Caridina sumatrensis* in the Western Ghats

When normally contracted it resembles a median longitudinal section of a cone in outline. In length an adult individual can extend instantaneously from 0·5 mm. to 2·0 mm. The integument is colourless and transparent and the rings on the cuticle very narrow. The tentacles are extremely short and have a bluntly rounded tip; they are soft and apparently devoid of cuticle; when the animal is fully extended they have the appearance of being mounted on short peduncles. The mouth opens between them at the base of a depression which becomes crateriform when the proboscis is fully retracted and the whole animal fully extended. There are two eyes situated on the anterior half of the dorsal surface some distance behind the base of the tentacles; the eyes are directed forwards and outwards; they are black in colour.

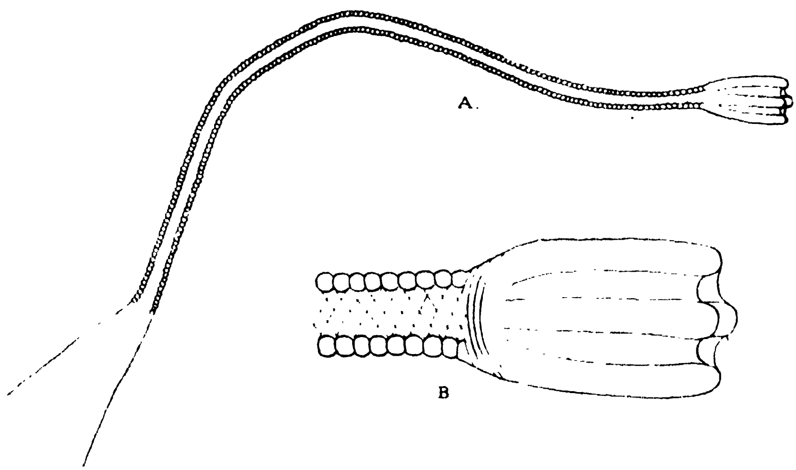

FIG. 1.—Chitinous armature of intromittent organ of *Caridinicola indica.*
A. The entire armature, very highly magnified.
B.—The terminal cup, still more highly magnified. The stem or intermediate portion and the basal funnel are represented in optical section.

When the animal is fully contracted the posterior sucker sometimes becomes almost heart-shaped, but as a rule it resembles the figure formed by a straight line the extremities of which are curved upwards through the greater part of a circle, the distance apart of the incomplete circle thus formed varying with the state of contraction of the animal.

Alimentary canal.—The mouth opens into an elongate cylindrical but highly muscular pharynx (oesophagus) which can be thrust out bodily to nearly half the length of the animal. The tip of this organ is surrounded by a circle of minute prominences on each of which a sense-organ provided with a minute chitinous tooth is situated; the whole ring is folded inwards when the proboscis is retracted. Strong, almost transverse retractor muscles, are

attached to the base of the pharynx. The intestine is rather longer and much more bulky than the pharynx; it is indistinctly sacculated at its anterior end.

Genitalia.—Only the penis need be described here. The chitinous part of this organ (fig. 1) consists of three regions:—(1) a proximal, funnel-shaped base, (2) an elongate cylindrical stem and (3) a cup-shaped apex. The basal funnel occupies about $\frac{1}{6}$ of the length of the whole structure and has a perfectly smooth external surface; it is almost twice as long as its basal diameter. The stem is about 34 times as long as its own transverse diameter, maintains the same diameter throughout its length, is circular in cross-section and occupies $\frac{5}{6}$ of the whole structure. It is ornamented externally with minute rounded prominences with which it is closely covered, the prominences forming parallel transverse rings round it. The terminal cup is about $1\frac{1}{4}$ times as long as broad and only about $\frac{1}{10}$ the length of the stem. Its sides, which are nearly parallel, are supported by four equidistant vertical bars, each of which is about equal in breadth to the space which separates it from the next bar. At the rim of the cup the bars project upwards for a short distance, their tips being bluntly rounded.[1]

Excretory system.—A pore which I believe to be excretory is situated on each side of the body close to the edge of the dorsal surface and a little posterior to the eye. These pores are easily seen in living specimens.

Eggs.—The eggs are nearly circular as seen from the side but broadly oval as seen from above. Each is provided with a stalk considerably shorter than its own diameter. They are somewhat variable in size but measure on an average about $0{\cdot}24 \times 0{\cdot}19$ mm. in dorsal view. The external covering is chitinous but very thin and quite smooth; it has a distinct yellowish tinge.

Type (a specimen mounted in glycerine) No. Z.E.V. [illegible], Ind. Mus.

Localities, etc.—River Mahanaddi and canal opening thereinto at Cuttack and R. Mahanaddi at Sambalpur, Orissa (February and March); river Ganges near Rajmehal, Bengal (March) (*B. L. Chaudhuri*).

Hosts.—*Caridina propinqua*, de Man (4) and *C. sumatrensis*, Bouvier (3).

II.—BIOLOGICAL.

The first specimens of *Caridinicola* were found attached to antennae of prawns of the genus *Caridina* taken at Cuttack in February and preserved in spirit. Others were discovered loose in the same bottle. They were, naturally enough, mistaken for small leeches by my assistant who was sorting out the contents of the bottle. As the species was evidently one of considerable interest, I took the opportunity to revisit Cuttack last March and found the worm abundant in the gill-chambers of *C. propinqua*,

[1] These details can only be seen with the aid of an oil-immersion lens after the specimen has been treated with caustic potash.

which swarmed among water-weeds at the edge of the Mahanaddi and also in a canal at the same place. Loose specimens were subsequently found in bottles of *Caridina sumatrensis* from Sambalpur in Orissa and Rajmehal in Bengal.

In the river and canal at Cuttack small Decapod and Schizopod Crustacea are extremely abundant. At least three species of *Caridina* (*C. nilotica*, Roux) (*s.l.*), *C. propinqua*, de Man, and *C. sumatrensis*, Bouvier, occur among weeds at the edge, and also numerous small (mostly immature) Palaemonidae; while the water is often full of large shoals of the little estuarine Mysidae *Potamomysis assimilis* and *Macropsis orientalis*, Tattersall (10).

In spite of a careful search, I did not find *Caridinicola* on any species of *Palaemon* or Mysidae at Cuttack or on *Caridina nilotica*. I cannot, however, be sure that it did not occur on *C. sumatrensis*, although all the specimens of *Caridina* on which I know that I took it are assigned by Mr. Kemp to *C. propinqua*: for the immature individuals of the two prawns resemble one another very closely.

I have not been able to find *Caridinicola* on *Caridina propinqua* in the neighbourhood of Calcutta, but this may be due to the fact that the prawn in this district is only found in distinctly brackish water, whereas the water of the Mahanaddi at Cuttack is very nearly, if not quite, fresh. That of the Mahanaddi at Sambalpur and of the Ganges at Rajmehal is of course quite fresh. Nothing is yet known of the distribution of *Caridina propinqua*, which has hitherto been recorded only from the Ganges delta, but it is very closely related indeed to *C. fossarum*, Heller, from Persia, and it is probable that closely allied forms extend all over the territory intermediate between that country and Lower Bengal. *C. sumatrensis* appears to be distributed over a considerable part of the Oriental Region.

The host of *Scutariella* is *Atyäephyra desmarestii*, the only non-cavernicolous European Atyid.

The habitual position of *Caridinicola* on its host is inside the gill-chamber, in which it lies attached to the gills. In most cases it can be readily detected in this position with the aid of a low-power microscope by an external examination of the prawn, whose integument is rarely pigmented so deeply as to render the operculum opaque. If the water in which the prawn is living, however becomes foul or if any noxious substance is added to it, the worm immediately emerges from the anterior end of the chamber and makes its way rapidly along the antenna or antennule. After gesticulating wildly in a manner that will be described presently, it then makes off in search of a new environment, being by no means wholly dependent on the prawn for the power of locomotion. For this reason very few specimens can be found on prawns which have been kept in captivity for more than a few hours, unless precautions are taken to keep the water fresh.

Caridinicola, though not markedly gregarious, is usually found in parties of two or three and, so far as my observations go,

such parties are usually confined to one gill-chamber, that on the other side of the prawn remaining vacant.

The eggs are attached to the gill-filaments of the host and are apparently deserted by their parent before they hatch. I found numerous examples far advanced in development at the beginning of March. There are as a rule not more than half a dozen on one host.

The food of *Caridinicola* consists mainly if not entirely of minute Protozoa and Protophyta. The contents of the alimentary canal as a rule consists of a brownish granular substance, probably excretory and containing large numbers of Diatom and Desmid skeletons. The tests of Rhizopod Protozoa are often present also in considerable numbers.

Prey is evidently captured by means of the pharynx, which can, as already stated, be thrust out bodily in the form of a pro-

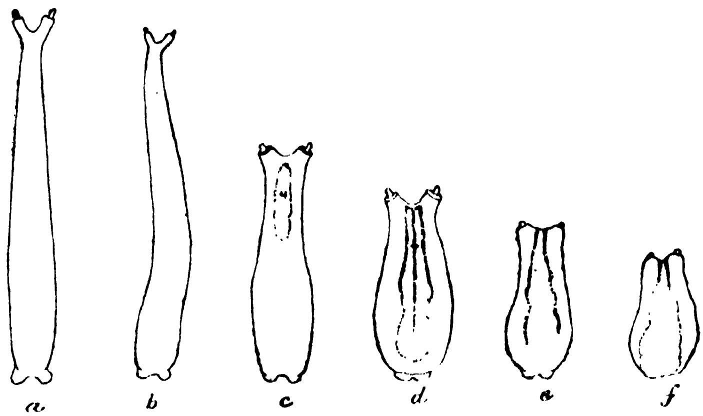

FIG. 2.—A single individual of *Caridinicola indica* in different stages of contraction.

boscis. I have not been so fortunate as to see the process, but Babu Abohya Charan Chowdhary, the Museum draftsman, tells me that while he was drawing the sketches reproduced in fig. 2, he saw the worm suddenly shoot out its proboscis and seize therewith a "small insect" which was running past. The proboscis was then rapidly withdrawn. The "small insect" was probably an Infusorian. The animal can easily be induced to extrude its proboscis by the exercise of pressure. Apparently the extrusion takes place more readily when the whole body is in a state of moderate contraction and is brought about by lateral contraction of the muscles of the body-wall, which are very well developed, aided by those of the organ itself. Retraction is affected by means of the retractor muscles situated at the base of the oesophagus. Doubtless the sense-organs surrounding the mouth enable the animal to decide whether the prey captured should be swallowed

or rejected, while the little teeth with which they are provided assist in its retention.

When *Caridinicola* is undisturbed in the gill-chamber of its host it habitually remains with its body in a state of moderate retraction, approximately as in fig. 2 *d*. The posterior sucker is firmly fixed to a gill-filament and the body is arched upwards and forwards in such a way that the eyes look directly forwards and outwards, the anterior extremity being bent considerably downwards If any disturbance occurs, however, the animal immediately straightens itself and elongates its body to the utmost. Such attitudes as those shown in fig. 2 *a* and *b* are only adopted just before it begins to move forwards. Apparently the rule that it emerges from the anterior end of the gill-chamber is absolute, and it invariably escapes *viâ* the antenna or antennule. As soon as it reaches the filamentous part of one of these appendages it stays its course and remains for some little time with the peculiar posterior sucker clasped round the hair like structure. The body is stretched to the utmost and moves rapidly upwards and downwards and from side to side, often gyrating almost as if on a pivot; but the sucker retains a firm hold. The tentacles during these evolutions exhibit curious twitching movements apparently neither correlated in the case of the two tentacles nor rhythmical. At length the *Caridinicola* releases hold of its host and drops to the bottom or onto a convenient weed. It seems probable that it habitually deserts its host at night, for I found it difficult to procure specimens on *Caridina* in the Mahanaddi early in the morning.

Progression is effected by means of "looping." The body is first held upright and stretched to the greatest possible length. The anterior extremity is then bent downwards and the surface along which progression is to be effected touched gently by the tentacles with their characteristic twitching movements. The two little anterior suckers next take hold, and the posterior sucker is released, drawn forward to a position immediately behind that occupied by them and then affixed again. The animal is now in readiness for a new move forwards.

Taking the above-stated observations into consideration, it seems probable that the tentacles are, as their structure would suggest, primarily of use as sensory organs. They seem to play no other part in progression than that of testing the ground before the anterior suckers attach themselves to it. They have, I think, another function, namely that of finding the right host. I noticed that if a *Caridinicola* were removed from its host and placed in a dish of water in which a *Caridina* of the right species was present, it immediately stood up in the water on its posterior extremity and, after twisting about in all directions and flicking its tentacles, finally directed them in the direction of the *Caridina* and then moved rapidly towards it. This happened whether the *Caridina* was dead or alive; indeed, even if it were torn in pieces, the little worm appeared to be attracted by the fragments and attached itself to one of them.

The eyes probably serve another purpose. As the worm sits in the gill-chamber of its host, they are, as I have already stated, directed straight in front of it. The current of water that flows constantly through the gill-chamber must bring in many of the little organisms on which *Caridinicola* feeds, and it is reasonable to assume that it catches these organisms by means of its protrusible pharynx. In order to do so, however, it must first become aware of their presence. There is every probability that it does so by seeing them, for the walls of the gill-chamber of *Caridina propinqua* are of glassy transparency and offer hardly any obstacle to the passage of light, while even those of *C. sumatrensis*, although they are as a rule much more densely pigmented, are by no means opaque.

SUMMARY.

1. The new genus *Caridinicola* constitutes with *Scutariella*, Mrázek, a family of "Temnocephaloidea" of which the latter is the type.
2. The family Scutariellidae is distinguished from other families of the group, among other characters, by the fact that the intestine extends to the posterior end of the body and that the genital organs, therefore, lie on its ventral surface instead of posterior to it.
3. *Caridinicola* is distinguished from *Scutariella* by the possession of a pair of small anterior suckers, by the terminal position of the mouth and by the peculiar shape of the posterior sucker.
4. *Caridinicola indica* is found only in association with certain species of the Atyid genus *Caridina*, namely *C. propinqua*, de Man, and *C. sumatrensis*, Bouvier.
5. It captures its prey by means of a protrusible pharynx or oesophagus.
6. Its tentacles are sense-organs and are apparently employed in testing the nature of the surface along which the animal is moving and also in finding the host.
7. The eyes are probably used for the detection of prey.
8. Progression is affected by "looping."

In conclusion I must again express my indebtedness to Mr Gravely and also to Mr. Stanley Kemp, who has given me great assistance in identifying the hosts of *Caridinicola indica*.

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XXIII. PRELIMINARY DESCRIPTION OF A FRESHWATER MEDUSA FROM THE BOMBAY PRESIDENCY.

By N. ANNANDALE, *D.Sc., F.A.S.B., Superintendent of the Indian Museum.*

Mr. F. H. Gravely of the Indian Museum and Mr. S. P. Agharkar of the Elphinstone College, Bombay, have recently obtained many specimens of the medusa referred to on p. 144, vol. lxxxvii of *Nature.* The following preliminary description is based on an examination of these specimens, which are several hundreds in number and come from the Yenna and Koyna valleys in the Satara district of the Bombay Presidency.

LIMNOCNIDA INDICA, sp. nov.

This medusa is closely allied to *L. tanganicae* (Bohm)[1] and *L. rhodesiae*, Boulenger,[2] but differs from both in the arrangement of its tentacles and sense-organs.

Dimensions.—The smallest specimen (fig. 1) I have seen is about 1·75 mm. in diameter and has probably been, at any rate when in a state of contraction, at least as deep as broad. Full-grown medusae are 15 mm. in diameter and almost three times as broad as deep.

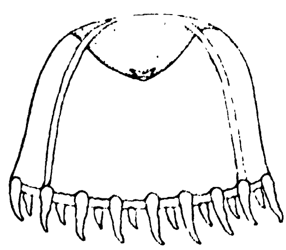


FIG. 1.—Young medusa of *Limnocnida indica.*

Umbrella.—The umbrella is very shallow and almost flat on the dorsal surface in the adult; in the young it is distinctly flattened above but not so broadly as in the adult.

[1] Günther (R.T.), *Ann. Mag. Nat. Hist.* (6) xi, p. 269 (1893); *Quart. Journ Micro. Sci.* xxxvi, p. 271 (1894); *P.Z.S.*, 1907 (ii), p. 643; Browne in Graham Kerr's *The Work of John Samuel Budgett*, p. 471 (1907); Boulenger (C.L.), *Quart. Journ. Micro. Sci.* lvii, p. 83 (1911).

[2] Boulenger (C.L.); *tom. cit.*, p. 427 (1912).

Manubrium.—The manubrium in most of Mr. Gravely's and Mr. Agharkar's specimens has the saucer-like form characteristic of the genus, consisting merely of a shallow ring and opening nearly as wide as the velum. In some few adult individuals, however, it is in a more or less contracted condition, while in one young one (fig. 1) its margin has been drawn together in such a way as to close the mouth almost completely, leaving only a minute star-shaped aperture. Mr. Gravely informs me that even the largest medusæ are quite capable of keeping their mouths closed, so long as they are in good health.

Gonads.—The gonads surround the manubrium as in other members of the genus. In the male the testis forms a uniform opaque white ring, but in the female the ring is grooved vertically at frequent intervals so that it has a crimped appearance. The grooves extend from the upper part of the manubrium downwards

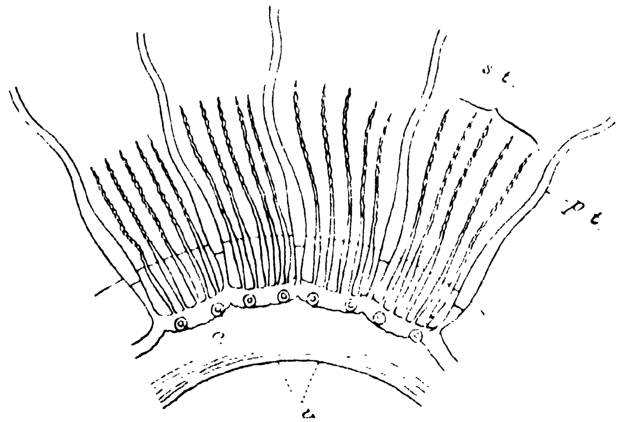


FIG. 2. Tentacles and sense-organs as seen from below, o. = otocyst ; p. t. = primary tentacle ; s.t. = secondary tentacle, v. = velum.

but do not reach its distal margin. They do not form distinct loculi in the ovary, for the ova, which are arranged horizontally, extend across them. A number of minute greenish cells (possibly symbiotic algae) exist in the outer covering of the ovary and give it a faint yellowish tinge. The eggs are very small; when ripe and apparently just about to be emitted from the ovary they are circular and from 0·04 to 0·06 mm. in diameter. At an earlier stage they are produced and pointed at one side.

Tentacles.—The tentacles appear, at any rate in the adult, to have a much more definite arrangement (fig. 2) than is the case either in *L. tanganicae* or *L. rhodesiae*. In general structure they agree with the tentacles of these species They may be divided at sight into two series that may be called primary and secondary; those of each series having a distinctive structure, position and number. The primary tentacles are much stouter at the base and

also much longer than the secondary ones. They extend upwards from the base through the jelly of the bell for a short distance and on emergence therefrom lie parallel to its external surface, each in a shallow groove, for about twice the distance for which they are enclosed in the jelly. This groove extends to the edge of the umbrella. On its termination the tentacle bends outwards and upwards and then downwards. At the point at which it does so there is only a very slight prominence on the surface of the umbrella. The base of the primary tentacle is both constricted from side to side and flattened dorso-ventrally. On the dorsal surface, where it is in contact with the mesogloea below the ectoderm of the bell, its endoderm contains numerous small polygonal cells of a yellowish colour due to their thickened walls.

The secondary tentacles are not only much shorter but also more nearly cylindrical and equal than the primary ones. They project practically straight out from their base, which is not, or only to a very slight extent, enclosed in the jelly.

The full number of tentacles is 384. Every primary tentacle is followed by five secondary ones arranged in a straight line with their bases a little further from the velum.[1] There are thus 64 series of six tentacles each, each consisting of one primary and five secondary tentacles. The radial tentacles are followed by five secondary tentacles just as other primary tentacles are.

It might be possible to divide the primary tentacles into several series by their length and in the adult medusa the radials are distinctly longer than the others; but the differences in this respect are slight and apparently unimportant. In the young medusa 1·75 mm. in diameter only two series can be distinguished and the radial tentacles are very little if at all longer than the others. At this stage there are 24 primary tentacles and each is followed by a single secondary one, which is distinguished not only by its smaller size but also by being placed a little lower on the edge of the bell as seen from the side or above.

Sense-organs. The otocysts are comparatively large, at least equallying the base of the largest tentacles in diameter. They also have a very definite arrangement in the adult. Every set of five secondary tentacles has two otocysts at its base and these two are separated from the next pair by the base of a primary tentacle and by an outward emargination of the inner edge of the ring of thickened tissue at the base of the tentacles. It is always quite clear, in well-preserved specimens, that the otocysts are not situated at the base of the primary tentacles and are not surrounded by anything like a tentacular bulb. In the young medusa already alluded to there are only three fully formed otocysts in each quadrant, *i.e.*, only twelve in all; while in an older medusa measuring 3·25 mm. in diameter there are five in each quadrant.

[1] Owing to the fact that the base of the primary tentacle is embedded in the jelly, this tentacle, unless a very careful examination is made from below, has the *appearance* of arising *further* from the velum than the secondary tentacle.

In the adult medusa the total number is 128. The sense-organs have the structure characteristic of *Limnocnida*.

Nematocysts.—The nematocysts resemble those of other species of *Limnocnida* both in shape and in arrangement. Round the margin of the bell they form a " nettle-band," in which they are found in various stages of development, always lie parallel to the external surface and never possess cnidocils. In the basal part of the primary tentacles they have the same position and still lack cnidocils. In this region they are very numerous. From a point a short distance beyond that at which the tentacle projects from the edge of the bell, however, they are arranged in very definite papillae. In these they stand out almost vertically from the surface and are provided with cnidocils. On the distal part of the tentacle the papillæ are arranged in transverse rings round it, each ring consisting of four papillae. On the secondary tentacles the papillae extend nearly to the base

Types (many specimens from Medha, Yenna valley, between Mahableshwar and Satara). No. Z.E.V. $\frac{5101}{7}$ Ind. Mus. (*F. H. Gravely* : May, 1912).

Distribution.—Pools in streams in the Western Ghats that finally enter tributaries of the Kistna river, Satara district, Bombay Presidency.

On the manubrium of specimens from Tambi in the Koyna valley I found numerous examples of the Infusorian *Trichodina pediculus*, Ehrenberg, a species which in Europe lives symbiotically on *Hydra* and other aquatic organisms.

XXIV. ON A NEW GENUS OF INDIAN THRIPS (THYSANOPTERA) INJURIOUS TO TURMERIC.

By RICHARD S. BAGNALL, *F.L.S.*, *F.E.S.*

(Plate vii.)

Through the kindness of Dr. N. Annandale I am able to describe the following interesting species of Thrips which was submitted to me with other Indian material in 1909. The specimens were collected more than thirty years ago, and on that account are not in such good condition as one would wish. I have however made a greatly enlarged drawing which shows the chief features of both sexes, and whilst the following description is a very complete one, considering the fragmentary state of the material, I hope later to have the pleasure of examining some newly collected specimens and thus be enabled to more accurately describe and figure certain parts.

Apart from its economic importance the species is one of considerable interest. It belongs to the sub-order Terebrantia and in certain features, such as the general character of the head and prothorax and the form of the antennæ, it would appear to be closely related to the genus *Heliothrips*, but a number of strong and peculiar characters (italicized in the generic description) are of such importance, I consider, as to render it advisable to place the genus into, at least, a sub-family of its own, the Panchaetothripinae.

Dr. Annandale has sent me the following transcription of the reference to the specimens, which appeared in the "Indian Museum Notes," Vol. 1, 1889–1891 –Entomology Notes—by E. C. Cotes, p. 109:—

"Specimens were received on 21st May, 1889, from the Board of Revenue, Madras, through the Superintendent, Government Central Museum, Madras. *Sutta thegulu*, small black-winged insect, frequently jumps from one place to another. This attacks the plant when two months old. The leaves become rolled up, greenish in colour, turning pale yellow, and the leaves gradually become dry. This spoils the turmeric crop, and rhizomes are not developed. Eggs are also deposited on the back of the leaves. *Sutta thegulu* is considered to be a severe form of attack."

Order THYSANOPTERA.

Suborder **Terebrantia.**

Fam. THRIPIDAE, Hal.

Sub-fam. *PANCHAETOTHRIPINAE*, mihi.

Gen. PANCHAETOTHRIPS, nov.

Head short and strongly transverse, *posteriorly strongly chitinized in the form of a raised collar*; frons depressed; cheeks roundly contracted before collar. Eyes prominent and protruding, ocelli present. *Antennae* long, eight-jointed, joints three and four very long and slender, five and six broadly united, the style bristle-like with the eighth joint much longer than the penultimate. Maxillary palpi long and slender, three-jointed. Prothorax strongly transverse, without prominent bristles. Pterothorax large. Wings present, not reticulated; spines on fore-wing exceptionally long and strong; *fore-vein apparently merged with costa, and hind-vein obsolete.*

Abdomen broadly ovate, *depressed and margined laterally; tenth segment in the female cylindrical and almost closed ventrally; Ovipositor very long and slender, almost straight. Anal spines exceptionally long and strong.*

Type *Panchaetothrips indicus* mihi.

PANCHAETOTHRIPS INDICUS, sp. nov.

♀ Length 1·3 mm. Length of last abdominal segment about 0·25 mm. Colour brown or yellow-brown, the pterothorax, the last abdominal segment and often the hind part of body darker; sides of pterothorax shaded with grey. Fore-tibiae yellow at apex, intermediate and hind fermora yellowish basally and apically, and the tibiae lighter at knees and shaded thence from brown to clear yellow at apex; all tarsi yellow. First antennal joint yellowish-brown, second concolorous with head, joints three to five clear yellow, almost white, shaded with light brown at tips; apical joints light brown.

Surface of head lightly reticulated, most strongly laterally and in the space between each posterior ocellus and eye; transversely striated below collar. Strongly transverse, widest across eyes; space between eyes almost three times the width of an eye; frons slightly produced, separating the basal antennal joints and having the apex narrowly emarginate. Forehead depressed from about a line drawn across the anterior fifth of the eyes; cheeks slightly rounded and thence strongly narrowed basally to collar which is apparently raised laterally and dorsally. Eyes large, prominent and very coarsely facetted; ocelli rather large, oviform; anterior

ocellus forwardly directed, placed in centre of forehead on a line drawn through the anterior fifth of eyes; posterior pair on a line drawn through the posterior third of eyes, the space separating them being as great as that between each ocellus and eye. Mouth-cone reaching across prosternum. Maxillary palpi three-jointed, long and slender. Antennæ widely separated at base, more than three times as long as the head; first joint short, cylindrical and narrower than the second; second widest at middle where it is about as broad as long, slightly narrowed distally and truncate at apex; third and fourth extremely slender, almost spindle-formed; fifth slightly stouter and broadly jointed to the sixth which is roundly narrowed apically; seventh styliform, parallel sided, and eighth continued in the form of a bristle. Relative lengths of joints:—6, 12, 24, 19·5, 17, 10, 5, 15. In one specimen the fourth joint is only very little shorter than the preceding.

Prothorax strongly transverse, without any conspicuous spines; surface finely and irregularly striated transversely. Pterothorax large; mesothorax roundly widened to juncture with the metathorax which has the sides roundly narrowed to the base of abdomen. Both meso- and metathorax laterally convex and with the surface reticulated. Surface of all the legs similarly reticulated; hind pair much longer than the others. Tibia of each hind leg furnished with a series of minute bristles for practically the whole length of the inner margin. Wings strong and reaching to the last abdominal segment; fore-wing narrowing rather unevenly from the basal fourth; basal part with a series of four long strong bristles on the fore-margin, the third being the longest, and a series of ten very long and strong spines on the costa, the last of which is the shortest. There are three spines on the basal part of the fore-vein; this vein appears to be carried to the extreme tip in the form of a thickened fore-margin, and is furnished in the apical half with six spines. There is one short and one long spine just under the first costal spine, but there appears to be no trace whatever of a hind-vein nor of any spines set on a line corresponding with such a vein. The fore-fringe is poorly developed whilst the cilia of the hind-fringe are closely spaced, long and slightly wavy. The hind-wing has the median vein well-developed, and the hairs of the fore-fringe are much shorter and more widely spaced than those on the hind margin.

The abdomen is strongly depressed and margined laterally; and excluding the last segment is broadly oval, in some specimens circular. Towards the apex the posterior angles of the segments are produced into overlapping spinous processes. The last segment is very large and elongated in the form of a tube, bearing at its apex four long and two shorter spines, all of which are exceptionally stout. The apex of the ninth segment is furnished with a series of long, stout spines, the longest over-reaching the tip of the last segment; the eighth is furnished at its posterior margin with similar but short spines. Ovipositor very long and slender, almost straight.

♂. Smaller and narrower, end of abdomen and genital armature as shown in plate vii, figure 2. Sternites two to six with an elongated chitinous thickening.

Habitat.—India; on the leaves of turmeric (*Curcuma longa*), Madras, 1889.

EXPLANATION OF PLATE VII.

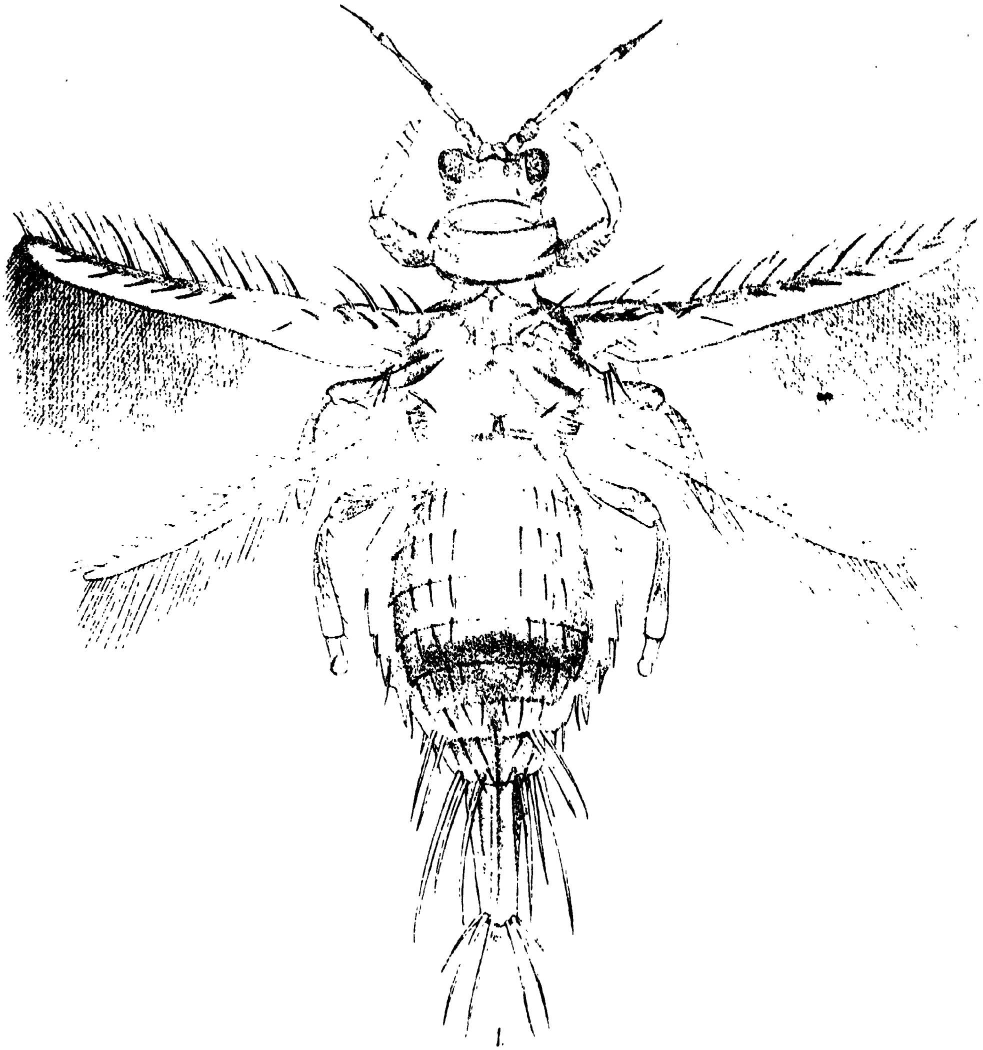
FIG. 1.—*Panchætothrips indicus* gen. et sp. nov. ♀ × 85.

" 2. " " abdomen of ♂ × 85.

" 3. " " ovipositor, ♀ × 85.

" 4. " " maxillary palpus × about 400.

" 5. " " end of right antenna × about 150.



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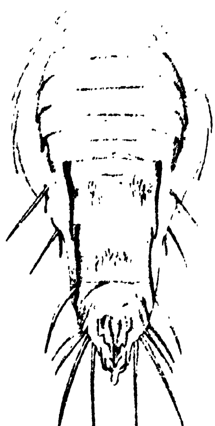

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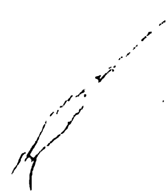

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XXV. THE AQUATIC CHELONIA OF THE MAHANADDI AND ITS TRIBUTARIES.

By N. ANNANDALE, *D.Sc.*, *F.A.S.B.*, *Superintendent, Indian Museum.*

The smaller streams that join to form the Mahanaddi (literally the "Great River") rise in various mountain-ranges in the Central Provinces of India and their united waters flow eastwards through Orissa to the Bay of Bengal, which they reach by several mouths. The Mahanaddi river-system is thus, on the eastern side, the most northerly system of any importance in Peninsular India properly so called, that is to say India south of the Ganges and the Indus. From the Gangetic system it is not separated either by any great distance or by any very important natural barrier; the most northerly mouth of the Mahanaddi is hardly more than 100 miles south of that of the R. Hughli, and there are neither mountain-ranges nor deserts between them.

Almost all that is known of the aquatic chelonia of the Mahanaddi river-system is contained in a paper by the late Dr. W. T. Blanford published in the *Journal of the Asiatic Society of Bengal* in 1870 and entitled "Notes on some Reptilia and Amphibia from Central India." In preparing my recent account of the Indian Trionychidae (*Rec. Ind. Mus.*, VII, pp. 151-180) I had before me most of the specimens of that family collected by Dr. Blanford but was unable, for lack of further material, to add much to what he had written. Now, however, thanks to the assistance given me by Mrs. F. deMonte of Cuttack in Orissa, Mr. T. Southwell, Deputy Director of Fisheries, Bengal, and Mr. B. L. Chaudhuri of the Indian Museum, it has become possible to deal in a more satisfactory manner both with Dr. Blanford's specimens and with those that have recently been acquired. Even so, I have only been able to prove the existence in the Mahanaddi and its tributaries of four aquatic tortoises, although at least eleven species that may be called strictly aquatic haunt the waters of the Ganges. These eleven species are the following:—

Trionyx gangeticus	Trionychidae.	*Hardella thurgi*	Testudinidae.
Trionyx hurum		*Batagur baska*	
Emyda granosa		*Kachuga lineata*	
Pelochelys cantoris		*Kachuga dhongoka*	
Chitra indica		*Kachuga smithii*	
		Kachuga tectum	

It is probable that at least three of the Gangetic Testudinidae also occur in the Mahanaddi system, viz., *Kachuga lineata*, *K. dhongoka* and *Batagur baska*. Of the first I have examined a young specimen taken by the late Dr. W. T. Blanford[1] in the lower reaches of the Godaveri, while the second is represented in the Indian Museum by quite typical examples from the Nerbadda and from Hyderabad, and the third by a skull from the Godaveri. Of the four forms, moreover, of which specimens have actually been obtained from the Mahanaddi, three are so closely related to Gangetic forms that they may be regarded merely as subspecies or local races thereof. The distribution of the fourth is still very imperfectly known; it may occur in the upper reaches of the Ganges.

The following are the four tortoises actually known to live in the Mahanaddi :—

TRIONYCHIDAE.

Trionyx gangeticus mahanaddicus, subsp. nov.
Trionyx leithii.
Emyda granosa intermedia.

TESTUDINIDAE.

Kachuga tectum intermedia.

The type specimens of all except *Trionyx leithii* are in the collection of the Indian Museum.

Fam. TRIONYCHIDAE.

TRIONYX GANGETICUS MAHANADDICUS, subsp. nov.

Trionyx gangeticus, Cuv. var. (*partim*), Blanford, *J.A.S.B.* (2) XXXIX, p. 344 (1870).

Trionyx gangeticus, Annandale, *Rec. Ind. Mus.* VII, Addenda Nos. 16781, 16791, 16792, 1087-8, p. 189, pl. v, fig. 2 (1912).

Closely allied as the Mahanaddi *Trionyx* is to the typical *T. gangeticus* I now think, after examining a fully adult specimen, that it must be recognized as a distinct race. It may be defined as follows :

Costal plates eight pairs, the last well developed and in contact in the middle line; two neurals between the first pair of costals; plates coarsely pitted and vermiculate. Epiplastra narrowly separated in front of the entoplastron, which forms an obtuse angle; existing plastral callosities very large, but no entoplastral callosity. Plastron as in *T. gangeticus*.

Head moderate; snout (on skull) considerably longer than orbit; interorbital region, in the adult, a little narrower than the nasal fossa; postorbital arch about half as wide as greatest diameter of orbit; mandible with inner edge strongly raised,

[1] Identified by Dr. Blanford as "*Batagur ellioti* ?", J.A.S.B. (2) 1879, p. 110.

forming a sharp ridge, which sends off a short triangular tubercle at the symphysis; *immediately in front of this tubercle a deep transverse semi-circular depression*; *diameter of mandible at symphysis equal to or a little less than greatest diameter of orbit*; *a faint longitudinal ridge in this region*; *alveolar part of the lower jaw relatively shorter than in* T. gangeticus; *coronal bone more nearly vertical*; *both jaws, in adult, less blunt at the tip.* Branchial skeleton as in *T. gangeticus.*

Dorsal surface of carapace pale olive without radiating lines in the young; *in the adult, dark olive with pale yellowish vermiculate veinings over the bony carapace and a more or less distinct marbling on the margin*; dorsal surface of limbs and neck dark olive, the anterior part of the latter marbled with dull yellow; *head yellowish olive* in old individuals, green in young ones: on the vertex behind the eyes two broad, dark olive ∧-shaped bars of irregular outline and often more or less interrupted; a straight but otherwise similar bar running obliquely on each side from behind the eye to near the gape; *numerous dark-olive spots of different sizes between and behind the bars, between the eyes, on the snout and the sides of the head*; *these spots growing relatively larger with age*; the whole ventral surface greyish white.

Distribution. Hasdo river (tributary of the upper Mahanaddi), Bilaspur district, Central Provinces; Sambalpur and Cuttack, Orissa.

Type.—Skeleton (skin of head in spirit): No. 17014 in the Indian Museum Register of Reptiles, etc.

I have examined four individuals in the flesh and after preservation, as well as the two young skulls obtained by Dr. Blanford in the Hasdo river: three of my specimens were obtained by Mrs. F. deMonte from fishermen at Cuttack, which is situated at the upper end of the Mahanaddi delta, while the fourth was taken at Sambalpur, some distance higher up the river, by Mr. B. L. Chaudhuri. In skull-characters the six individuals agree closely, allowance being made for differences in age. It is evident that in this race pigmentation increases with age, the opposite being the case in that of the Ganges; for the young specimens are stated by Dr. Blanford to have had no dark markings on the carapace and apparently only a dark veining on the head, while the largest individual examined (the type) was much darker than others of smaller size. The entire disk of this individual (a male) was 70 cm. long by 55 cm. broad, while the bony carapace was 38 cm. by 46 cm.

It is evident that Dr. Blanford was dealing with two distinct species in writing the description cited above, for the very young individuals to which he referred as being ocellate on the back actually represent not the new subspecies but *T. leithii*, Gray. The skull of that species is narrower than that of either form of *T. gangeticus*, the symphysis of the lower jaw longer and the inner edge of the mandible without any trace of a ridge.

The following are the measurements of four skulls of *T. gangeticus mahanaddicus*:—

	No. 17014.	No. 16790.	No. 15912	No. 1088.
Length	100 mm.	102 mm.	87 mm.	65 mm.
Greatest breadth ..	97 ,,	73 ,,	65 ,,	44 ,,
Length of snout ..	29 ,,	27 ,,	24 ,,	17 ,,
Length of orbit ..	18 ,,	15 ,,	15 ,,	13 ,,
Width of postorbital arch	8 ,,	7 ,,	8 ,,	4 ,,
Interorbital width ..	13 ,,	13 ,,	15 ,,	..
Width of nasal aperture	17 ,,	16 ,,	15 ,,	..
Length of mandibular symphysis	18 ,,	16 ,,	14 ,,	..

No. 1088 is one of Dr. Blanford's specimens from the Hasdo river in the Central Provinces; the other skulls are from Orissa. The length of the skull is measured in each case from the tip of the snout to that of the articular condyle.

TRIONYX LEITHII (GRAY) (1870)

Aspilus cariniferus (*partim*), Gray, *Suppl. Cat. Sch Rept.* I, p. 101 (1870).

Trionyx gangeticus, Cuv. var. (*partim*), Blanford, *J. A. S. B.* (2) XXXIX, p. 341 (1870)

Trionyx leithii and *gangeticus* (*partim*), Gray, *P. Z. S.* 1873, pp. 49 and 47, fig. 3 (p. 48), pl. viii.

Trionyx sp. ?, Blanford, *J. A. S. B.* (2) XLVIII, p. 110 (1879).

Trionyx leithii, Boulenger, *Cat. Chel. Brit. Mus.*, p. 249 (1889) and *Faun. Brit. Ind.* Rept, p. 12; Annandale, *Rec. Ind. Mus.* VII, pp. 159, 160, fig. 2 (1912).

Young specimens of this species were obtained by the late Dr. W. T. Blanford in the Hasdo river. The species is also known from the Western Ghats and the Godaveri, Kistna and Nelambar rivers and is said to occur in the Indus or the Upper Ganges.

EMYDA GRANOSA INTERMEDIA. Annandale.

Emyda vittata ? Peters, Blanford, *J. A. S. B.* (2) XXXIX, p. 343 (1870).

Emyda vittata, *id.*, *ibid.* XLVIII, p. 111 (1879): Annandale, *Rec. Ind. Mus.* I, p. 397 (1907).

Emyda granosa intermedia, *id. ibid.* VII, pp. 171, 172, pl. VI, fig. 3 (1912).

I have recently examined several additional specimens from Cuttack and Sambalpur. They agree well with the type, except that one old male has the shell olive-brown instead of olive-green.

The dark reticulation is, however, well marked on its disk. The disk of my largest specimen (a female) measures 306 × 270 mm. The race is apparently found all over central and eastern India from the headwaters of the Mahanaddi to the mouth of the Godaveri.

Fam. TESTUDINIDAE.

KACHUGA TECTUM INTERMEDIA (Blanford).

Emys (*Pangshura*) *tectum*, Bell var. *intermedia*, Blanford, *J.A.S.B.* (2) XXXIX, p. 339, pl. xiv.

Pangshura tecta var. *intermedia*, *id.*, *ibid.* XLVIII, p. 110.

Kachuga intermedia, Boulenger, *Faun. Brit. Ind.* Rept., p. 43.

This form is very common both at Cuttack and at Sambalpur; I have examined a large series of living examples as well as many skeletons and skulls. So far as I can discover, there is no *constant* structural difference between it and the *K. tectum* of the Ganges, although in the great majority of individuals the second neural plate is much shorter. I have, however, seen individuals of *intermedia* in which it was no longer than is usual in *tectum*, and of the true *tectum* in which it was just as short as it is in *intermedia*; nor is the outline of its posterior margin by any means constant in either race. The coloration of the two races is, however, always different, at any rate in fresh or well preserved specimens, and in young individuals of *intermedia* the carapace is never so deep in the middle as it is in the Gangetic race. The carapace of *intermedia* is always much paler than it is in the true *tectum* and instead of the posterior part of the head being occupied by a broad V-shaped red or orange mark, it is for the most part of the same dull olive as the snout. There is always a conspicuous red spot behind each tympanum and sometimes less distinct and paler red marks can be detected on the top of the head behind the eyes. There are no spots on the dorsal surface of the limbs, but the thighs and often the upper arms are striped with pale olive. In the true *tectum* it is noteworthy that the V-shaped red or orange mark on the head is occasionally broken up into a coronal of spots.

The shell of the largest specimen of the race *intermedia* that I have measured is 260 mm. long by 245 mm. wide, the measurements being taken along the curves. I cannot distinguish the skulls of the two races.

It is probable that the race *intermedia* occurs all over the river-systems of the Mahanaddi and the Godaveri and that the typical *tectum*[1] is confined to those of the Indus, the Ganges and the Brahmaputra. Several specimens from the Godaveri in the collection of the Indian Museum were labelled "*tectum*" by the late Dr. J. Anderson, but a close comparison has assured me that

[1] Siebenrock regards *Pangshura cochinchinensis*, Tirant, as a synonym of *K. tectum*: see Tirant, *Etudes Div. Miss. Pavie* III, p. 494, and Siebenrock, *Zool. Jahrb.* Suppl. X, 1909, p. 454.

they actually represent the southern race, the colour of the carapace being quite distinct. It is probable moreover, that other herpetologists, misled by the belief that in *intermedia* the second neural plate is always transverse, may have identified specimens incorrectly. Mr. Boulenger records specimens of *K. tectum* from the Cuttack river and the Deccan (*Cat. Chel. Brit. Mus.*, p. 59), but both in his "Catalogue" and in the "Fauna" he states that the recent distribution of *K. tectum* is the "Ganges and Indus systems." In this I think he is right, for *K. cochinchinensis* (Tirant) probably represents a distinct race, as that of the Upper Brahmaputra may also do.

XXVI. ON A SMALL COLLECTION OF RECENT CRINOIDS FROM THE INDIAN OCEAN.

By Austin H. Clark, *B.A.*, *F.R.G.S.*

Some time after the completion of my report [1] upon the Crinoids collected by the "Investigator" I received a few additional specimens which had escaped notice when that collection was sent to me.

In order that the published records of the large and important collection belonging to the Indian Museum may be complete these specimens are listed here.

One of the items of interest brought to light by the study of this material is the discovery of a new species of *Oligometra* allied to the Australian *O. adeonae*, in the Andaman Islands. Up to a few weeks ago *O. adeonae* in North Australia and the Aru Islands and *O. thetidis* in New South Wales were supposed to represent a somewhat anomalous type of the genus peculiar to Australia; but very recently a related species, *O. marginata*, has been described from Solor Strait in the Lesser Sunda Islands, where it was dredged by the Dutch steamship "Siboga." Not only does this new species greatly increase the known geographical range of this curious group, but it possesses an additional interest in being intermediate in its characters between this group within the genus *Oligometra* and the species of the genus *Prometra*, furnishing new evidence of the very close inter-relationships between all of the genera comprised within the family Colobometridae.

Almost equally interesting is the new species of *Zygometra* herein described. Although not greatly different from *Z. comata*, which occurs from the Mergui Archipelago to the Philippine Islands, it appears to be quite distinct, and it appears to occupy a habitat considerably to the westward of that of any other species of the family.

Family COMASTERIDÆ.

Subfamily *CAPILLASTERINÆ*.

Capillaster sentosa (P. H. Carpenter).

8° 51′ 30″ *N. lat.*, 81° 11′ 52″ *E. long.*: 28 *fathoms*. One small broken specimen.

[1] Echinoderma of the Indian Museum, Part VII, Crinoidea Calcutta, 1912.

Family ZYGOMETRIDÆ.

ZYGOMETRA ANDROMEDA, sp. nov.

The centrodorsal is thin discoidal, the bare dorsal pole large, slightly concave, finely granular, 2·5 mm. in diameter.

The cirri are XXI, 27-30 (usually the latter), 13 mm. to 15 mm. long; the longest segments are about one-third broader than long; dorsal spines, which are long and sharp, are developed from the eighth or ninth segment onward.

The arms are about twenty-five in number, 50 mm. to 55 mm. long; the division series and arms resemble those of *Z. comata*, but the distal edges of the radials and the proximal and distal edges of the ossicles of the division series and, to a lesser extent, of the first two brachials, are thickened and everted, this eversion being finely scalloped or tuberculated so that the edges of the ossicles appear beaded; the summit of the eversion may be smooth, but is usually very finely spinous; the flattened lateral edges of the ossicles of the division series and the first two brachials are very finely spinous; the dorsal surface is unmodified; the distal edge of the first syzygial pair bears a row of small rounded obscure tubercles, and there is usually a similar, but less evident row at the syzygial line. Beyond the fourth brachial the arms are smooth, resembling those of *Z. comata*.

P_1 is composed of twenty-four segments and is 9·5 mm. long.

Locality.—India.

EUDIOCRINUS MINOR, A. H. Clark.

Andaman Islands.—One specimen, with arms 35 mm. long.

Family HIMEROMETRIDÆ.

HETEROMETRA REYNAUDII (J. Müller).

India. Two specimens; one of these has twenty arms about 65 mm. long; one IIBr 2, and nine IIBr 4 (3+4) series are present; the other has twelve arms 25 mm. long; there are 15-18 cirrus segments of which the fifth or sixth and following bear dorsal spines.

? *India.*—Two very small specimens; one of these has ten arms 15 mm. long; the cirri are XIV, the longest with 17 segments of which the ninth and following bear dorsal spines, the shorter with 12 segments, none of which bear dorsal spines; the other individual is also ten armed; the longest cirri are 10 mm. long with 22 segments, dorsal spines being developed from the seventh onward; the smallest cirri are 2·5 mm. long with 9 segments, quite without dorsal spines, and exactly resembling the cirri of young examples of *Antedon bifida*.

HETEROMETRA PULCHRA, A. H. Clark.

Arrakan Coast. - Two small broken specimens.

Family STEPHANOMETRIDÆ.

STEPHANOMETRA INDICA (E. A. Smith).

8° 51′ 30″ *N. lat.*, 81° 11′ 52″ *E. long.*; 28 *fathoms.*—Two specimens; P_1 has fifteen segments.

Family MARIAMETRIDÆ.

DICHROMETRA PROTECTUS (Lütken).

India.—One specimen with thirty arms.

Family COLOBOMETRIDÆ.

DECAMETRA MOEBIUSI, A. H. Clark.

? *India.*—One specimen.

COLOBOMETRA DISCOLOR, A. H. Clark.

Off Table Island, Andamans; 15-35 *fathoms.*—One specimen.

PROMETRA BREVICIRRA, A. H. Clark.

? *India.*—One specimen.

OLIGOMETRA INTERMEDIA, sp. nov.

The centrodorsal is small, discoidal, the dorsal pole flat, papillose, 0·8 mm. in diameter.

The cirri are very short, very stout, and strongly curved, IX, 10-11, 2·5 mm. long; the earlier segments are broader than long, but the sixth and following are about as broad as long; the second segment has the distal dorsal edge produced and finely spinous, this becoming on the fourth a median transverse ridge with prominent lateral angles which project slightly beyond the lateral profile of the segment and encroach slightly on the lateral surface; on the outer segments this transverse ridge becomes narrower and partially resolves itself into paired transversely elongate spines, at the same time moving to a position proximal to median; here there may be an eversion of the median part of the distal dorsal edge of the segments so that the segments may present more or less of the "bidentate" appearance characteristic of *O. adeonæ* and *O. marginata.*

The ten arms are about 18 mm. long; the division series and arms in general resemble those of *O. serripinna*, but the ossicles of the IBr series and the first brachials have broad and prominent ventrolateral processes as in the species of *Stephanometra.*

P_a is absent; P_1 is 2·5 mm. long with eight segments, and is the longest and stiffest pinnule on the arm, though it is not especially stout; the first segment is half again as broad as long, the second is about as long as broad, the third is twice as long as broad, the fourth and fifth are between two and one half and three times as long as broad; the following rapidly decrease in size; the third and following bear long and prominent spines at the prismatic angles which after the fourth are very conspicuous; P_2 is 2 mm. long with eight segments, exactly resembling P_1; P_3 is small and slender, about 1 mm. long with about eight segments; the following pinnules are weak and delicate, not tapering so rapidly as P_3.

Locality.—Andaman Islands.

OLIGOMETRA SERRIPINNA (P. H. Carpenter).

"*Investigator*" *Station No.* 95; 15-25 *fathoms*.—One specimen; the synarthrial tubercles and the processes on the lower pinnules are strongly marked.

Arrakan Coast.—One small and immature specimen.

Family TROPIOMETRIDÆ.

TROPIOMETRA ENCRINUS, A. H. Clark.

Sadras.—One specimen.

Family ANTEDONIDÆ.

Subfamily *ZENOMETRINÆ*.

PSATHYROMETRA MAJOR, A. H. Clark.

"*Investigator*" *Station No.* 115; 188-220 *fathoms*.—One small specimen; there are four or five cirrus sockets in the outer columns.

PSATHYROMETRA MIRA, A. H. Clark.

West of Alleppey, Travancore (9° 34′ 57″ *N. lat.*, 75° 36′ 30″ *E. long*); 406 *fathoms*.—One specimen, not quite mature, and one typical specimen.

Thirteen miles south by west from North Sentinel Island, Andamans; 130-250 *fathoms*.—One small specimen.

Seven miles south-east by south from Ross Island; 265 *fathoms*.—One small specimen.

PSATHYROMETRA INUSITATA, A. H. Clark.

Seven miles south-east by south from Ross Island; 265 *fathoms*.—One small specimen.

Family PENTAMETROCRINIDÆ.

PENTAMETROCRINUS VARIANS (P. H. Carpenter).

"Investigator" Station No. 114; 922 *fathoms.*—One small specimen.

XXVII. CONTRIBUTIONS TO THE FAUNA OF YUNNAN BASED ON COLLECTIONS MADE BY J. COGGIN BROWN, B.Sc., 1909-1910.

PART VIII. EARTHWORMS.

By J. STEPHENSON, *D.Sc.*, *Major, I.M.S.*, *Professor of Biology, Government College, Lahore.*

I received from the Indian Museum in November, 1911, four tubes containing earthworms, collected by Mr. J. Coggin Brown of the Geological Survey of India, in Yunnan and the Shan States. Of these one tube contained a single specimen, which, owing to its being sexually quite immature, was unidentifiable. The rest were all species of *Pheretima.*

PHERETIMA BROWNI, sp. nov.

A large number of specimens, all in a bad state of preservation, owing apparently to the whole of the specimens having been placed in far too small a quantity of preservative fluid

Tengyueh, Yunnan.

EXTERNAL CHARACTERS. *Length* 4 inches, maximum *breadth* 3 mm.; *segments* about 108. *Colour* dark brown, often with a purple tinge.

Prostomium small, prolobous.

First *dorsal pore* in the intersegmental furrow $^{11}/_{12}$.

Clitellum xiv—xvi = 3: no trace of annulation and no setæ visible on the clitellum.

Male apertures on segment xviii, nearly one-third of the circumference apart, with 12 setæ intervening The apertures are large, and are not situated on papillæ

Female aperture median, anteriorly in segment xiv.

Spermathecal apertures in furrows $^{7}/_{8}$ and $^{8}/_{9}$.

No *genital papillæ* or other special marks.

The *setæ* form a ring which is closed ventrally, and almost closed dorsally; the setæ are a little closer together ventrally than laterally and dorsally, and those of segments iv—ix are enlarged Numbers of setæ:—$^{77}/_{v}$, $^{74}/_{x}$, ca. $^{41}/_{xviii}$, $^{44}/_{xx}$.

INTERNAL ANATOMY.—The *septa* are so softened that it is impossible to tell which are thickened, probably $^{6}/_{7}$ and $^{7}/_{8}$, possibly also $^{10}/_{11}$ and $^{11}/_{12}$ are stouter than the rest: and $^{8}/_{9}$ is probably absent.

The *gizzard* occupies segments viii—ix. The *intestine* begins in xv. There are a pair of *intestinal diverticula* in xxvi; these are elongated, conical, without secondary projections; they extend forwards through segments xxv—xxiii.

The last *heart* is in segment xiii.

The *seminal funnels* are in x and xi, enclosed in small testicular sacs; the sacs of each pair are separate, not conjoined across the middle line. The *seminal vesicles* are paired, of moderate size, in segments xi and xii.

The *prostates* are of moderate size, and flattened against the body-wall; each consists of two principal lobes, one anterior, the other posterior to the origin of the duct; both lobes are divided up into numerous lobules.

The *spermathecæ* possess an irregularly shaped, roughly ovoid ampulla, with a broad short duct. The diverticulum arises from near the distal end of the duct; it is variable, often coiled, thin and narrow for the most part, and dilated at its internal end; when uncoiled it is about equal in length to the ampulla or somewhat shorter.

PHERETIMA DIVERGENS (Mchlsn.) var. YUNNANENSIS var. nov.

A single specimen, in a tube along with *P. hawayana.*

Tengyueh, Yunnan.

EXTERNAL CHARACTERS. *Length* 3¾ inches; *breadth* 3 mm., *segments* 108, *colour* yellowish brown.

Prostomium epilobous ½.

No *dorsal pores* visible in front of clitellum.

Clitellum includes segment xiv—xvi = 3; there are a few setæ ventrally on xvi, otherwise the clitellum is without setæ.

Male apertures on segment xviii, at an interval of nearly one-third of the circumference, in the line of the ring of setæ. About 12 setæ intervene between the apertures: there are however no setæ immediately to the inner side of these latter.

Female aperture a minute pore, mid-ventrally on xiv.

Spermathecal apertures small, in intersegmental furrows 5/6, 6/7, 7/8 (on right side only those in 5/6 and 6/7 visible). The interval between the apertures of opposite sides is equal to about 11 or 12 setæ.

Genital papillæ are present on segments vii, viii and ix, in pairs, on the anterior part of the segment between the setal ring and the anterior boundary of the segment; the interval between the papillæ of each pair is equal to 7 or 8 setæ.

Midventrally, in the line of the setal rings of vi—ix and xi—xiii, there are appearances which might possibly represent faintly marked copulatory areas, but more probably are due to post-mortem changes, or to the specimen having been rubbed.

The *setæ* form closed rings. Those on the anterior segments as far back as vii or viii are enlarged somewhat, but not markedly. The intervals between the setæ are approximately the same all

round the ring. The following numbers were counted:—ca. ^{38}/vii, ca. ^{47}/xiii, ^{46}/xvii, and 50—56 in the middle region of the body.

INTERNAL ANATOMY.—*Septa* $^{5}/_{6}$, $^{6}/_{7}$, $^{7}/_{8}$ are moderately thickened, $^{8}/_{9}$ and $^{9}/_{10}$ are absent, $^{10}/_{11}$ and $^{11}/_{12}$ considerably thickened, $^{12}/_{13}$ and $^{13}/_{14}$ slightly so.

The *gizzard* occupies segments viii—ix. The *intestine* begins in xvi; there is a well-marked typhlosole. A pair of large conical *intestinal diverticula* originate in xxvi.

The last *heart* is situated in segment xiii; '*blood glands*' are present, a pair in each segment, along the course of the dorsal vessel on the intestine, as in *P. posthuma*.

The *nephridial system* is micronephric; the nephridia are very minute, scattered over the internal surface of the body-wall.

Testes and *seminal funnels* are enclosed in testicular sacs, of moderate size, paired, quite separate from each other, in segments x and xi. The two *vasa deferentia* of each side unite into one at the posterior boundary of xi.

The *seminal vesicles*, in segments xi and xii, are paired, of com-

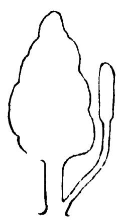


FIG. 1.—Spermatheca of *Pheretima divergens* var. *yunnanensis*.

paratively small size, irregularly lobulated, with in every case a fairly distinct mesially projecting lobe.

Prostates are absent. The terminal portion of the male duct on each side is much thickened and looped.

The *spermathecæ* (fig. 1) are in four pairs, corresponding to furrows $^{5}/_{6}$—$^{8}/_{9}$. The ampullæ are of an inverted pear shape (the broader end below), the duct is thick and short, one-third the length of the ampulla. From the distal end of the duct arises the diverticulum, thin and tubular for most of its extent but swollen at its proximal end; the length of the diverticulum varies, it is mostly $1\frac{1}{2}$—$1\frac{3}{4}$ as long as the ampullla and duct; the figure was drawn from one of the organs where it was even longer than the upper of these limits. In the case of the most posterior pair of spermathecæ in the specimen here described, the swollen end of the diverticulum was more rounded, and not so elongated as in the rest.

Corresponding to the papillæ on segments vii, viii, and ix, there are seen on the inner side of the body wall small *accessory glands*, white and tuft-like; sessile on the body wall (ix), or with a short thick duct (vii), or consisting of two minute tufts (viii).

The present species has not so far been recorded from India. Since in the specimen here described there are certain fairly well marked differences from the typical form,—in size, in the presence of setæ on the clitellum, in the details of the spermathecal apparatus,—it appears advisable to describe it as a separate variety.

The figure of the spermathecal apparatus may be compared with that given in the original description of the worm (Michaelsen, Arch. für Naturgesch., vol. 58, 1892), the gizzard is there said to occupy segments ix—x, and the hearts to be situated in segments x—xii.

PHERETIMA HAWAYANA (Rosa).

This species has been previously described under a number of different names (*cf.* Beddard, Proc. Zool. Soc. Lond., 1900, p. 645), from many different countries. The species is apparently a variable one, and one form, previously described separately as *P. barbadensis* (Bedd.), but included in *P. hawayana* by Beddard in the paper just referred to, is considered by Michaelsen to have the value of a subspecies (Michaelsen, Mem. Ind. Mus., vol. 1, No. 3, 1909, p. 187).

I give a fairly complete description of the specimens in the present collection, since they are of interest from the fact that they are in some ways intermediate between the typical form of *P. hawayana* and the subspecies *barbadensis*, and hence help to confirm Beddard's view as to the specific identify of the two.

Six specimens, in a tube with a single specimen of *P. divergens* var. *yunnanensis*.

Tengyueh, Yunnan.

EXTERNAL CHARACTERS.—*Length* 2—4 inches; *breadth* 3—4 mm.; *segments* 88—90. *Colour* of most of the specimens a dirty yellowish brown.

Prostomium epilobous $^1/_2$; sometimes with a transverse fissure in addition completing the anterior boundary of segment i, *i.e.* a combined prolobus and epilobous condition.

First *dorsal pore* in intersegmental furrow $^{10}/_{11}$.

Clitellum includes segments xiv—xvi=3; without setæ.

Male pores on xviii, $^2/_7$ of the circumference apart on small or very small papillæ.

Female pore on xiv, mid-ventral, in a transversely extended depression.

Spermathecal apertures three pairs, in furrows $^5/_6$, $^6/_7$, $^7/_8$.

Genital papillæ, etc.—Internal to the male apertures on segment xviii, and either in the same transverse line with them or at a slightly posterior level, were a number of small pigmented spots, either one or two on each side. These had, except in one case, the character of depressions; in only the one exception was the spot a papilla. When more than one spot was present, they were separate, not fused.

In one specimen a pair of small papillæ, each with a darker centre, was present on the posterior part of segment vii, nearly in the groove $^{7}/_{8}$, and slightly median to the position of the spermathecal apertures.

The *setæ* formed an unbroken ring; they were slightly closer together ventrally than dorsally; those of segments iii—viii were enlarged. The following numbers were counted: $^{44}/$ix, $^{49}/$xi, $^{58}/$xii, $^{64}/$xix, $^{68}/$xxvii.

INTERNAL ANATOMY.—*Sepia* $^{5}/_{6}$ and $^{6}/_{7}$ moderately thick, $^{7}/_{8}$ considerably thickened, $^{8}/_{9}$ and $^{9}/_{10}$ absent, $^{10}/_{11}$, $^{11}/_{12}$ somewhat thickened.

Intestinal diverticula small, conical, originating in segment xxvii; in one specimen there were one (right side) or four (left) small rounded secondary diverticula on the ventral border of the primary diverticula.

Small *testicular sacs*, completely separated, in x and xi; *vesiculæ seminales*, irregularly lobulated in xi and xii.

Prostates large, in six segments (xvii—xxii), divided up into a corresponding number of lobes by the septa. A thick yellow duct, with an S-shaped curve, rises from the middle portion of the gland in segment xix, the vas deferens joins the gland anterior to, but near, the origin of the prostatic duct.

Accessory prostates correspond in position to the genital spots on segment xviii.

The *spermathecæ* are three pairs; the ampulla is ovoid in shape, narrowing gently to the duct, which is of considerable length, three-quarters as long as the ampulla. The diverticulum is often coiled; it is a narrow tube which when uncoiled equals the ampulla in length in some cases, while in others it is only two-thirds or one-half as long.

An *accessory gland* was present on each side in the specimen which possessed the papillæ posteriorly on segment vii; the glands corresponded in position with these papillæ, and were sessile on the inner face of the body-wall.

Remarks.—Writing of Beddard's inclusion of *P. barbadensis* with *P. hawayana* Michaelsen ‖ says:—"I am not yet quite convinced that this view is correct. Till now I have not seen a specimen—and I have examined many—which aroused any doubt as to whether it should be placed in the typical form or in the subsp. *barbadensis*. In the generally more robust typical form with stronger setæ in the anterior part of the body the papillæ near the male pores are always united at each side, occupying an oblong oval area medial from the male pores and mostly somewhat oblique. In the subsp. *barbadensis* the papillæ near the male pores are scattered, partly very near the male pores, partly near the median ventral line."

In the present specimens the dark spots near the male apertures had as a rule the character of slight depressions rather than of papillæ; they were not confluent, and in this respect resembled the papillæ of the subsp. *barbadensis* rather than those

of the typical form. But the setæ of the anterior segments were stronger than those of the remaining segments, which Michaelsen, in the passage just quoted, gives as a characteristic of the typical form

In the '*Tierreich*' (Oligochaeta, 1900) Michaelsen describes the two forms as separate species. In the fact that the setæ are disposed in an unbroken chain, and that the clitellum occupies the whole of three segments, the present form agrees with *P. barbadensis*; while in having secondary diverticula from the intestinal cæca, and a curved prostatic duct, it resembles *P. hawayana*. Occupying thus an intermediate position, it serves to confirm Beddard's view of the unity of these two species.

PHERETIMA POSTHUMA (L. Vaill.).

A number of specimens, mostly mature.

Ye-nan-Gyaung, Magwe, N. Shan States, Upper Burma.

XXVIII. A CATALOGUE OF THE ASIATIC NAIADES IN THE COLLECTION OF THE INDIAN MUSEUM, CALCUTTA, WITH DESCRIPTIONS OF NEW SPECIES.

By H. B. Preston, *F.Z.S.*

Plate VIII.

In compiling the following catalogue the scheme generally followed is that used by Mr. C. T. Simpson in his valuable work "Synopsis of the Naiades, or Pearly Freshwater Mussels"[1]; occasionally however the author, after examining the large series of specimens not only in the Indian, but also in the British Museum, has had to deviate from that system, but as far as possible Simpson's work has been incorporated in the present catalogue.

The author's thanks are especially due to Mr. Edgar A. Smith, I.S.O., of the British Museum, whose unrivalled knowledge and great courtesy in placing specimens in his hands for examination have largely helped him in his labour.

Three extra-Indian species are figured in the plate that accompanies this catalogue: the new Indian forms here described will be figured later in a volume of the "Fauna of British India."

Fam. UNIONIDAE.

Subfam. *UNIONINAE*, Swainson, 1840.

Gen. **Hyriopsis**, Conrad, 1853

1. **Hyriopsis bialatus**, Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 579,=*Unio delphinus*, Grunner, Arch. für Naturg., I, 1841, p. 276, pl. ix, figs. 1, 1a-c,=*Margaron (Unio) delphinus*, Lea, Syn., 1852, p. 19; 1870, p. 28. *Unio megapterus*, Morelet, J. de Conch., XXI, 1863, p. 159.

Siam (Russel coll.). Reg. Nos. [illegible], [illegible]; Pahang River, Malay Peninsula (Dr. Cantor), Reg. No. [illegible], Cambodia, Reg. No. [illegible].

2. **Hyriopsis cumingii** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 579,=*Unio cumingii*, Lea, Proc. Ac. Nat. Sci. Philad., VII, 1852, p. 54; Lea, Jl. Ac. Nat. Sci. Philad., IV, 1860, p. 240, pl. xxxv, fig. 120,=*Margaron (Unio) cumingii*, Lea, Syn., 1852, p. 19; 1870, p. 28.

Shanghai Market, Reg. No. [illegible]; Shanghai, Reg. No. [illegible].

[1] Proc. U.S. Nat. Mus., Washington, D.C., XXII, 1900, pp. 501–1044.

3. **Hyriopsis myersianus** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 580,=*Unio myersianus*, Lea, Proc. Ac. Nat. Sci. Philad., VIII, 1856, p. 92; Jl. Ac. Nat. Sci., III, 1857, p. 290; Obs., VI, 1857, p. 10, pl. xxii, fig 2,=*Margaron* (*Unio*) *myersianus*, Lea, Syn., 1870, p. 28,=*Unio housei*, Lea, Proc. Ac. Nat. Sci. Philad., VIII, 1856, p. 92; Jl. Ac. Nat. Sci. Philad., III, 1858, p. 291, pl. xxiii, fig. 3,=*Margaron* (*Unio*) *housei*, Lea, Syn., 1870, p. 28.

Cambodia, Reg. No. [illegible]; Pitsanuloke, N. Siam (H. W. Biggie), Reg. No. [illegible].

4. **Hyriopsis schlegeli** (von Martens), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 581,=*Unio schlegeli*, von Martens, Mal. Blatt., VII, 1861, p. 55; Kobelt, Abh. Senck. Nat. Ges., XI, 1879, p. 421, pl. xiv,=*Barbala schlegeli*, Paetel, Conch. Sam., III, 1890, p. 175.

Lake Biwa, Japan (J. Anderson), Reg. Nos. $\frac{521}{1}$, $\frac{525}{1}$, $\frac{526}{1}$, and $\frac{527}{1}$.

Gen. **Chamberlainia**, Simpson, 1900.

5. **Chamberlainia hainesiana** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus, XXII, p. 582,=*Unio hainesianus*, Lea, Proc. Ac. Nat. Sci. Philad., VIII, 1856, p. 92; Jl. Ac. Nat. Sci Philad., III, 1857, p. 289, pl. xxi, fig. 1,=*Margaron* (*Unio*) *hainesianus*, Lea, Syn., 1870, p. 28,=*Unio imperialis*, Morelet, Rev. et Mag. Zool., XIV, 1862, p. 480.

Siam (*ex coll.* Richtofen), Reg. Nos. [illegible] and [illegible].

Gen. **Cristaria**, Schumacher, 1817.

Subgen. **Cristaria**, Schumacher, 1817.

6. **Cristaria plicata** (Leach), von Ihering, Abh. Senck. Nat. Ges., XVIII, 1893, p. 147; Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, pp. 583–584,=*Dipsas plicatus*, Leach, Zool. Miscell., I, 1815, p. 120, pl. iii,=*Mytilus plicatus*, Solander in Gray, Ann. of Phil., IX, 1825, p. 27,=*Appius plicatus*, Gray in Menke, Syn. Meth. Moll., 1830, p. 106,=*Margarita* (*Dipsas*) *plicatus*, Lea, Syn., 1836, p. 47; 1838, p. 28,=*Margaron* (*Dipsas*) *plicatus*, Lea, Syn., 1852, p. 46; 1870, p. 74,=*Unio plicatus*, Sowerby, Conch. Icon., XVII, 1868, pl. liv, fig. 280,=*Dipsas plicatus*, Troschel, Arch. für Naturg., XIII, 1874, p. 272; Kobelt, Abh. Senck. Nat. Ges., XI, 1879, p. 429, pls. xv xvii, xviii, fig. 1, =*Barbala plicata*, H. and A. Adams, Gen. Rec. Moll., II, 1857, p. 501, pl. cxvii, figs. 4, 4*a*,=*Anodonta plicata*, Schrenck, Reis. und F. Am. Lande, II, 1867, p. 704, pl. xxvii, fig. 4,=*Anodonta* (*Dipsas*) *plicata*, Clessin, Conch. Cab. Ano., 1876, p. 240, pl. xxi, figs. 1. 2,=*Cristaria tuberculata*, Schumacher, Ess. Nouv. Syst., 1817, p. 140, pl. xx, fig. 2,=*Anodonta dipsas*, Blainville, Man. Mal., 1825, p. 538, pl. lxvi, fig. 2,=*Symphanota bialata*, Lea, Tr. Am. Phil. Soc., 1830, p. 445, pl. xiv, fig. 24,=*Unio bialata*, Hanley, Test. Moll., 1842, p. 219; Biv. Shells, 1843, p. 214, pl.

xxii, fig. 4,=*Barbala bialata*, Chenu, Mas., 1859, p. 145, fig. 717,=*Unio bialatus*, Deshayes, Tr. Elem. Conch., 1839, p. 19, pl. xxxi, fig. 3,=*Anodonta magnifica*, Clessin, Conch. Cab. Ano., 1870, p. 123, pl. xxxv, fig. 1,=*Dipsas occidentalis*, Heude, Conch. Fl. Nank., IX, 1885, pl. xlvi,=*Barbala occidentalis*, Paetel, Conch. Sam., III, 1890, p. 175,=*Barbala plicatula*, Paetel, Conch. Sam., III, 1890, p. 175.

Cambodia, Reg. No. [illegible]; Lake Biwa, Japan (J. Anderson), Reg. Nos. $\frac{328}{1}$, $\frac{330}{1}$, $\frac{331}{1}$, $\frac{332}{1}$; Shanghai, Reg. No. [illegible].

7. **Cristaria bellua** (Morelet), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, 1900, p. 584,=*Anodonta bellua*, Morelet, Rev. et Mag. Zool., XVIII, 1866, p. 167; Ser. Conch., IV, 1875, p. 331.

Cambodia, Reg. No. [illegible].

8. **Cristaria herculea** (Middendorff), von Ihering, Abh. Senck. Nat. Ges., XVIII, 1893, p. 146; Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 584,=*Anodonta herculea*, Middendorff, Bull. Phys. Math. Ac. St. Pet., VI, 1848, p. 303; Sib. Reise, II, 1851, p. 278, pl. xxi, fig. 5, xxii, figs. 1, 2, xxvi, figs. 1, 2,=*Anodonta (Dipsas) herculea*, Clessin, Conch. Cab. Ano., 1875, p. 175, pl. lix, figs. 1, 2,=*Barbala herculea*, Paetel, Conch. Sam., III, 1890, p. 175,=*Dipsas plicata* var. *clessini*, Kobelt pars, Abh. Senck. Nat. Ges., XI, 1879, p. 429, pl. xv?=*Craspedodonta smaragdina*, Anton, Verz. der Conch., 1839, p. 16, No. 592; Clessin, Conch. Cab. Ano., 1875, p. 93, pl. xxvii, fig. 2.

Amur region, Reg. No. [illegible]; Lena River, E Siberia, Reg. No. [illegible].

Subgen. **Pletholophus**, Simpson, 1900.

9. **Pletholophus swinhoei** (H. Adams), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 586, *Unio swinhoei*, H. Adams, Proc. Zool. Soc. London, 1866, p. 319; Sowerby, Conch. Icon., XVI, pl. xlii, fig. 232,=*Anodonta swinhoei*, H. Adams, Proc. Zool. Soc. London, 1866, p. 446; Clessin, Conch. Cab. Ano., 1876, p. 125, pl. lxxv, fig. 6,=*Anodon swinhoei*, Sowerby, Conch. Icon., XVI, 1868, pl. xxvii, fig. 108,=*Margaron (Unio) swinhoei*, Lea, Syn., 1870, p. 45.

Canton, Reg. Nos. [illegible], [illegible]; Formosa, Reg. No. [illegible].

10. **Pletholophus reiniana** (von. Martens), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 585: von. Martens, Jahrb. Mal. Ges., II, 1875, p. 136, pl. iii, fig. 4,=*Dipsas reiniana*, Kobelt, Abh. Senck. Nat. Ges., XI, 1879, p. 432, pl. xii, fig. 4, xxi, fig. 2,=*Anodonta reiniana*, von Ihering, Abh. Senck. Nat. Ges., XVIII, 1893, p. 147,=*Barbala reiniana*, Paetel, Conch. Sam., III, 1890, p. 175.

Lake Biwa, Japan (J. Anderson), Reg. No. [illegible].

Gen. **Lepidodesma**, Simpson, 1896.

11. **Lepidodesma languilati** (Heude), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, pp. 586 and 587,=*Unio*

languilati, Heude, J. de Conch., XXII, 1874, p. 116; Conch. fluv. Nank., 1875, Pt. I, pl. vii,=*Lepidodesma languilati*, Simpson, Proc. U.S. Nat. Mus., XVIII, 1896, p. 311 =*Cristaria megadesma*, von Martens, S.B. Nat. Fr., 1875, p. 3; Mal. Bl., XXVI, 1875, p. 187,=*Barbala megadesma*, Paetel, Conch. Sam., III, 1890, p. 175.

China, Reg. No. [illegible].

Gen. **Pilsbryoconcha**, Simpson, 1900.

12. **Pilsbryoconcha exilis** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 587,=*Anodonta exilis*, Lea, Tr. Am. Phil. Soc., VI, 1839, p. 81, pl. xxii, fig. 68,=*Margarita* (*Anodonta*) *exilis*, Lea, Syn., 1838, p. 32,=*Anodon exilis*, Catlow and Reeve, Conch. Nom., 1845, p. 66,=*Margaron* (*Anodonta*) *exilis*, Lea, Syn., 1852, p. 51; 1870, p. 82,=*Monocondylaea exilis*, Paetel, Conch. Sam., III, 1890, p. 174,=*Anodonta siliqua*, Küster? Conch. Cab. Ano., 1852, p. 57, pl. xiv, fig. 5,=*Anodonta polita*, Mouss., L. and Süss. Moll., Java, 1849, p. 98, pl. xix, figs. 2 and 3,=*Margaron* (*Anodonta*) *polita*, Lea, Syn., 1852, p. 53,=*Anodon politus*, Sowerby, Conch. Icon., XVII, 1867, pl. xii, fig. 36,=*Monocondylaea compressa*, Lea, Proc. Ac. Nat. Sci. Philad., VII, 1863, p. 190; Jl. Ac. Nat. Sci. Philad., VI, 1866, p. 30, pl. xi, fig. 29,=*Pseudodon compressa*, Conrad, Am. Jl. Conch., I, 1865, p. 213,=*Margaron* (*Monocondylaea*) *compressa*, Lea, Syn., 1870, p. 73,=*Spatha compressa*, Paetel, Conch. Sam., III, 1890, p. 188,=*Anodon jacana*, Sowerby, Conch. Icon., XVII, 1867, pl. xi, fig. 33,=*Anodon gracilis*, Sowerby? Conch. Icon., XVII, 1867, pl. xiv, fig. 45,=*Anodon kelletti*, Sowerby? Conch. Icon., XVII, 1867, pl. xix, fig. 71,=*Anodonta sempervirens*, Deshayes, Nouv. Arch. de Mus., X, 1874, p. 120, pl. v, figs. 4, 5.

Java, Reg. No. [illegible].

Gen. **Anodonta** (Bruguiere em.), Lamarck, 1799.

13. **Anodonta woodiana**, Lea,=*Symphanota woodiana*, Lea, Tr. Am. Phil. Soc., V, 1834, p. 42, pl. v, fig. 13,=*Margarita* (*Anodonta*) *woodiana*, Lea, Syn., 1836, p. 48; 1838 p. 29,=*Anodon woodiana*, Catlow and Reeve, Conch. Nom., 1845, p. 68; Sowerby, Conch. Icon., XVII, 1870, pl. xxxvi, fig. 149,=*Anodonta woodiana*, Hanley, Test. Moll., 1842, p. 215; Biv. Shells, 1843, p. 315; H. and A. Adams, Gen. Rec. Moll., II, 1857, p. 503; Clessin, Conch. Cab. Ano., 1875, p. 146, pl. xlviii, figs. 1, 2,=*Margaron* (*Anodonta*) *woodiana*, Lea, Syn., 1852, p. 47; 1870, p. 75,=*Symphanota magnifica*, Lea, Tr. Am. Phil. Soc., V, 1834, p. 42, pl. v, fig. 14,=*Margarita* (*Anodonta*) *magnifica*, Lea, Syn., 1836, p. 48; 1838, p. 29,=*Anodonta magnifica*, Hanley, Test. Moll., 1842, p. 215; Biv. Shells, 1843, p. 215; H. and A. Adams, Gen. Rec. Moll., II, 1857, p. 503; Chem. Man., 1859, II, p. 156, fig. 719,=*Anodon magnifica*, Catlow and Reeve, Conch. Nom., 1845, p. 67; Sowerby, Conch. Icon., XVII, 1870, pl. xxv, fig. 96,=*Margaron* (*Anodonta*) *magnifica*, Lea, Syn., 1852, p. 47; 1870, p. 75,=?*Anodonta aurata*, Küster, Conch. Cab. Ano., 1853,

p. 30, pl. vi, fig. 2,=*Anodon rotundatus*, Swainson, Ex. Conch., 2nd Ed., 1841, pl. xxxvii.=*Anodon gibbum*, Benson. Jl. As. Soc. Beng., XXIV, 1855, p. 135,=*Anodon gibba*, Sowerby, Conch. Icon., XVII, 1867, pl. vi, fig. 13; Heude, Conch. Fl. Nank., VII, 1881, pl. li, fig. 95,=*Margaron* (*Anodonta*) *gibba*, Lea. Syn. 1870, p. 81. von Martens, Nov. Conch., IV, 1876, p. 150, pl. cxxxvi, figs. 6, 7,=*Anodonta gibba*, Clessin, Conch. Cab. Ano., 1875, p. 181, pl. lx, fig. 4,=*Anodon tricostatus*, Sowerby, Conch. Icon., XVII, 1870, pl. xxv, fig. 98,=*Anodonta edulis*, Heude, J. de Conch., XXII, 1874, p. 117,=*Anodon edulis*, Heude, Conch. Fl. Nank., I, 1875. pl. viii, fig. 18,=*Anodonta edulis*, Paetel, Conch. Sam., III, 1890, p. 179,=*Anodon securiformis*, Heude, Conch. Fl. Nank., III, 1877, pl. xviii, fig. 30,=*Anodonta securiformis*, Paetel. Conch. Sam., III. 1890, p 107,=*Anodon nigricans*. Heude, Conch. Fl. Nank., III, 1877, pl. xix, fig. 41, *Anodonta nigricans*. Paetel, Conch Sam., III, 1890, p. 182, *Anodon piscatorum*, Heude, Conch. Fl. Nank., IV, 1878, pl. xxvi, fig. 56, *Anodon elliptica*, Heude, Conch. Fl. Nank., IV 1878, pl. xxvii, fig. 58 *Anodon fusca*. Heude, Conch. Fl. Nank., IV, 1878, pl. xxviii, fig. 59,=*Anodon frinianum*, Heude, Conch. Fl. Nank., IV, 1878, pl. xxviii, fig. 60,=*Anodon joreti*, Heude, Conch. Fl Nank., IV, 187-, pl. xxix, fig. 62,=*Anodon striata*, Heude, Conch. Fl. Nank., IV, 1878, pl. xxx, fig 63,=*Anodonta striata*, Paetel, Conch. Sam., III, 1890, p. 185. *Anodon pacifica*, Heude, Conch. Fl. Nank., IV, 1878, pl. xxxii, fig. 66, *Anodon tumida*, Heude, Conch. Fl. Nank., V, 1879, pl. xxxv, fig. 69, *Anodonta tumida*, Paetel, Conch. Sam., III, 1890, p. 186,=*Anodon subtetragona*, Heude, Conch. Fl. Nank., V, 1879, pl. xxxvi, fig. 70. *Anodon lineata*, Heude. Conch. Fl. Nank., V, 1879, pl. xxxvi, fig. 71, *Anodonta lineata*, Paetel, Conch. Sam., III, 1890, p. 181, =*Anodon irregularis*, Heude, Conch. Fl. Nank., V, 1879, pl. xxxvii, fig. 73,=*Anodonta irregularis*, Paetel, Conch. Sam., III, 1890, p. 180,=*Anodon melanochlorea*, Heude, Conch. Fl. Nank., 1879, pl xxxviii, fig. 74. *Anodonta melanochlorea* Paetel, Conch. Sam., III 1890, p. 182, *Anodon agricolarum*, Heude, Conch Fl. Nank., V, 1879, pl. xxxix, fig. 75. *Anodonta agricolarum*, Paetel, Conch. Sam., III, 1890, p. 176, *Anodon mingorum*. Heude, Conch. Fl. Nank., V, 1879, pl. xl, fig. 77,=*Anodonta mingorum*. Paetel, Conch. Sam, III, 1890. p. 182, *Anodon bigibba*, Heude, Conch. Fl. Nank., VI, 1880, pl. xli, fig. 78,=*Anodonta bigibba*, Paetel, Conch. Sam., III, 1890, p. 177, =*Anodon despecta*, Heude, Conch. Fl. Nank., V, 1880, pl. xli, fig. 79,=*Anodon obtusa*, Heude, Conch. Fl. Nank., VI, 1880, pl. xlii, fig. 80,=*Anodon navicula*, Heude, Conch. Fl. Nank., VI, 1880, pl xlii, fig 81,=*Anodonta navicula*, Paetel, Conch. Sam., III, 1890, p. 182,=*Anodon orbicularis*, Heude, Conch. Fl. Nank., VI, 1880, pl. xlii, fig. 82,=*Anodonta orbicularis*, Paetel, Conch. Sam., III, 1890. p. 182,=*Anodon limosa*, Heude, Conch. Fl. Nank., VI, 1880, pl. xliii, fig. 83,=*Anodonta limosa*, Paetel, Conch. Sam., III, 1890, p. 181,=*Anodon livida*, Heude, Conch.

Fl. Nank., 1880, pl. xliii, fig. 84,=*Anodonta livida*, Paetel, Conch. Sam., III, 1890, p. 181,=*Anodon castanea*, Heude, Conch. Fl. Nank., 1880, pl. xliii, fig. 85,=*Anodonta castanea*, Paetel, Conch. Sam., III, 1890, p. 177,=*Anodon minuta*, Heude, Conch. Fl. Nank., VI, 1880, pl. xliv, fig. 86,=*Anodonta minuta*, Paetel, Conch. Sam., III, 1890, p. 182,=*Anodon succinea*, Heude, Conch. Fl. Nank., VI, 1880, pl. xliv, fig. 87,=*Anodonta succinea*, Paetel, Conch. Sam., III, 1890, p. 185,=*Anodon chiniana*, Heude, Conch. Fl. Nank., VI, 1880, pl. xlv, fig. 88,=*Anodonta, chiniana*, Paetel, Conch. Sam., III, 1890, p. 177,=*Anodonta scaphydium*, Heude, Conch. Fl. Nank., VI, 1880, pl. xlvi, fig. 89,=*Anodonta scaphidium*, Paetel, Conch. Sam., III, 1890, p. 184, =*Anodon puerorum*, Heude, Conch. Fl. Nank., VII, 1880, pl. xlvii, fig. 90,=*Anodonta puerorum*, Paetel, Conch. Sam., III, 1890, p. 183,=*Anodon indecora*, Heude, Conch. Fl. Nank., VI, 1880, pl. xlviii, fig. 91,=*Anodonta indecora*, Paetel, Conch. Sam., III, 1890, p. 180,=*Anodon sorini*, Heude, Conch. Fl Nank., VII, 1881, pl. xlix, fig. 92,=*Anodonta sorini*, Paetel, Conch. Sam., III, 1890, p. 185,=*Anodon rosea*, Heude, Conch. Fl. Nank., VII, 1881, pl. l, fig. 93,=*Anodonta rosea*, Paetel, Conch. Sam.. VII, 1890, p. 184,=*Anodon aubreyi*, Heude, Conch. Fl. Nank., VII, 1881, pl. lii, fig. 97,=*Anodonta aubreyi*, Paetel, Conch. Sam., III, 1890, p. 176,=*Anodon confusa*, Heude, Conch. Fl. Nank., VII, 1881, pl. liii, fig. 99,=*Anodonta confusa*, Paetel, Conch. Sam., III, 1890. p. 178,=*Anodon obtusata*, Heude, Conch. Fl. Nank., VII, 1881, pl. liv, fig 100,=*Anodon rubella*, Heude, Conch. Fl. Nank, VII, 1881, pl. liv, fig. 100 bis,=*Anodonta rubella*, Paetel, Conch. Sam., III, 1890, p. 184,=*Anodon pulchella*, Heude, Conch. Fl. Nank, VII, 1881, pl. lv, fig. 101,=*Anodonta pulchella*, Paetel, Conch. Sam., III, 1890, p. 183,=*Anodon florida*, Heude, Conch. Fl. Nank., VII, 1881, pl lv, fig. 102,=*Anodonta florida*, Paetel, Conch. Sam., III, 1890, p. 179,=*Anodonta retusa*, Heude, Jl. de Conch., XXXII, 1884, p. 20,=*Anodon intermerata*, Heude, Conch. Fl. Nank., IX, 1885, pl. lxvii, fig. 130,=*Anodonta intermerata*, Paetel, Conch. Sam., III, 1890, p. 180,=*Anodon filippiana*, Heude, Conch. Fl. Nank., IX. 1885, pl. lxviii, fig 131,=*Anodonta filippiana*, Paetel, Conch. Sam., III, 1890. p. 183, =*Anodon fantozatiana*, Heude, Conch. Fl. Nank., IX, 1885, pl. lxix, fig. 132,=*Anodonta fantozatiana*, Paetel, Conch. Sam., III, 1890, p. 179.

Canton River, Reg. Nos. $\frac{4911}{1}$, $\frac{4912}{1}$; Shanghai, Reg. Nos $\frac{5022}{1}$, $\frac{5056}{1}$, $\frac{5042}{1}$, $\frac{607}{1}$, $\frac{5178}{1}$, $\frac{601}{1}$, $\frac{606}{1}$; N. China, Reg. No. $\frac{5241}{1}$; Zinzay. N. China, Reg. No. $\frac{5168}{1}$.

14. **Anodonta** sp. ? A single, malformed specimen. Kandahar, Reg. No. $\frac{1948}{1}$.

Gen. **Gabilliotia**, Servain, 1890.

15. **Gabilliotia euphratica** (Bourguignat), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 650.=*Unio euphraticus*,

Bourguignat, Test. Nov., 1852, p. 28; Cat. Rais., 1853, pl. iv, figs. 1—3,=*Pseudodon euphratica*, Conrad, Am. Jl. Conch. I, 1865, p. 233,=*Margaritana euphratica*, von Martens, Vorderas. Conch., 1874; Kobelt, Icon., new ed., II, 1886, p. 26, pl. xlv, fig. 266,=*Leguminaia euphratica*, Westerlund, Faun. Pal., II, Pt. 7, 1890, p. 188,=*Unio churchillianus*, Sowerby, Conch. Icon., XVI, 1868, pl. xcvi, fig. 526.

Bagdad, Reg. No. $\frac{1082}{1}$.

Gen. **Solenaia**, Conrad, 1868.

16. **Solenaia soleniformis** (Benson), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 656,=*Anodonta soleniformis*, Benson, Journ. As. Soc. Beng., V, 1836, p. 750,=*Spatha soleniformis*, Hanley and Theobald, Conch. Ind., pl. ix, fig. 1,=*Mycetopus soleniformis*, Fischer, Jl. de Conch., XXXVIII, 1890, p. 94,=*Margaron (Unio) bensoni*, Lea, Syn., 1870, p. 57,=*Mycetopus bensonianus*, Paetel, Conch. Sam. III, 1890, p. 186.

Cachar, Reg. Nos. $\frac{1700}{1}$, $\frac{9038}{1}$, $\frac{9040}{1}$.

Gen. **Margaritana**, Schumacher, 1817.

17. **Margaritana margaritifera** (Linnaeus), Schumacher, Ess. Nouv. Syst., I, 1817, p. 124, pl. x, fig. 4; Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 674-677, etc.,=*Mya margaritifera*, Lister, Hist. Anim. Ang. App., 1695, pl. i, fig. 1, etc.,=*Mya margaritifera, testa ovali oblonga, etc.*, Möller, Zool. Danicae, 1776, p. 245; Chemnitz, Conch. Cab. VI, 1782, p. 15, pl. i, fig. 5,=*Baphiae margaritifera*, Meuschen, Mus. Gevers., 1787, p. 472,=*Unio margaritifera*, Drapernaud, Tab. Moll. Fr., 1801, p. 107; Hist. Moll. Fr., 1806, p. 132, pl. x, figs. 17-19, pl. xi, fig. 5 ? etc.,=*Alasmodonta margaritifera*, Conrad, New F. W. Shells, 1834, p. 72,=*Margarita (Margaritana) margaritifera*, Lea, Syn., 1836, p. 45: 1838, p. 28,=*Margaron (Margaritana) margaritifera*, Lea, Syn., 1852, p. 43: 1870, p. 69,=*Baphia margaritifera*, H. & A. Adams, Gen. Rec. Moll., II, 1857, p. 499; III, pl. cxvii, figs. 2, 2*a*,=*Unio margaritiferus*, Retzius, Dis. S. Hist. Nat., 1788, p. 16; Spengler, Skriv. Nat. Selsk., III, 1793, p. 52; Turton, Conch. Ins. Brit., 1822, p. 241, pl. xvi, fig. 1,=*Alasmodon margaritiferus*, Brown, L. & F. W. Conch., 1836, p. 112, pl. xxi, fig. 13, pl. xxii, figs. 1, 3,=*Margaritana margaritiferus*, Westerlund, Faun. Pal., II, Pt. 7, 1890, p. 184,=*Alasmodon margaritifgrum*, Fleming, Hist. Brit. Moll., 1828, p. 417,=*Unio margaritifer* var. *minor*, Rossmässler, Icon., Pt. 2, 1835, p. 19, pl. ix, fig. 129,=*Unio margaritifer*, Küster, Conch. Cab., 1856, p. 130, pls. xxxviii, xxxix,=*Unio (Margaritana) margaritifera*, Schrenck, Reis. und F. in Amur Lande, II, 1867 ? p. 700,=*Unio auricularius*, Spengler, Skriv. Nat. Selsk., III, 1793, p. 44,=*Unio elongata*, Lamarck, An. sans. Vert., VI, 1819, p. 70,=*Damaris elongata*, Leach, Syn. Moll. Gt. Brit., 1852, p. 322,=*Margaritana elongata*, Westerlund,

Faun. Pal., II, Pt. 7, 1890, p. 185; Locard, Coq. de Fr., 1893, p. 149, fig. 162,=*Unio elongatus*, Nilsson, Hist. Moll. Swec., 1822, p. 16; Sowerby, Conch. Icon., XVI, 1868, pl. lxxvi, fig. 397,=*Alasmodonta arcuata*, Barnes, Am. Jl. Sci., VI, 1823, p. 227, pl. xii, fig. 20,=*Mya arcuata*, Eaton, Zool. Text book, 1826, p. 222, =*Alasmodon arcuata*, Stimpson, Shells of New Eng., 1851, p. 15; Küster, Conch. Cab., 1856, p. 293, pl. xxxix, fig. 1,=*Unio sinuata*, C. Pfeiffer, Nat. Deutsch L. & W. Moll., Pt. 2, 1825, p. 33, pl. vii, fig. 4,=*Unio roissyi*, Michaud, Comp. Hist. Moll. Fr., 1831, p. 112, pl. xvi, fig. 28,=*Margaritana roissyi*, Westerlund, Faun. Pal., II, Pt. 7, 1890, p. 186,=*Unio tristis*, Morelet, Moll. Portugal, 1845, p. 107, pl. xiii, fig. 2,=*Margarita* (*Unio*) *crassiamus*, Lea, Syn., 1836, p. 40; 1838, p. 26,=*Unio* (*Alasmodonta*) *dahuricus*, Middendorff, Bull. Phys. Math. Ac. St. Petersb., IX, 1850, p. ?; Sib. Reise, II, 1851, p. 275, pl. xxvi, figs. 3, 5, =*Unio dahuricus*, Middendorff, L. & S. Moll. Sib., 1859, p. 26,=*Unio* (*Margaritana*) *dahurica*, Kobelt, Abh. Senck. Nat. Ges., XI, 1875, p. 427; Kobelt, Faun. Jap. Ext., 1879, p. 143, pl. xiii, figs. 1, 2,= *Alasmodon falcata*, Gould, Proc. Boston. Soc. Nat. Hist., III, 1850, p. 294; Otia Conch., 1862, p. 87; U. S. Expl. Exp. XII, 1852, p. 433, figs. 545, 545*a*, 545*b*,=*Unio falcatus*, Sowerby, Conch. Icon., XVI, 1868, pl. lxxv, fig. 390,=*Unio* (*Alasmodonta*) *complanatus*, Middendorff, Sib. Reise, II, 1851, Pt. I, p. 273, pl. xxvii, figs. 1—6,=*Margaritana complanata*, Westerlund, Fauna Pal., II, Pt. 7, 1890, p. 187,=*Alasmodon yubaensis*, Trask, Proc. Cal. Acad. Sci., I, 1855, p. 30,=*Margaritana raveneliana*, Chenu, Man., 1859, II, p. 144, fig. 714.

Chitose, Yezo, Japan (J. Anderson), Reg. No. [illegible].

Gen. **Unio**, Retzius, 1788.

18. **Unio mussolianus**, Küster, Conch. Cab. Unio., 1861, p. 244, pl. lxxxii, fig. 1,=*Unio bourguignatianus*, Lea, Proc. Ac. Nat. Sci. Philad., VII, 1863, p. 189; Jl. Ac. Nat. Sci. Philad., VI, 1866, p. 54, pl. xviii, fig. 51,=*Margaron* (*Unio*) *bourguignatianus*, Lea, Syn., 1870, p. 39,=*Unio rasus*, Lea, Proc. Ac. Nat. Sci. Philad., VII, 1863, p. 189; Jl. Ac. Nat. Sci. Philad., VI, 1866, p. 50, pl. xvii, fig. 47,=*Margaron* (*Unio*) *rasus*, Lea, Syn., 1870, p. 58,=*Unio mosulensis*, Lea, Proc. Ac. Nat. Sci. Philad., VII, 1863, p. 190; Jl. Ac. Nat. Sci. Philad., VI, 1866, p. 52, pl. xvii, fig. 49,=*Margaron* (*Unio*) *mosulensis*, Lea, Syn., 1870, p. 48,=*Margaritana mosulensis*, Paetel, Conch. Sam., III, 1890, p. 173.

River Tigris, Reg. No. [illegible].

19. **Unio modiola**, sp. n. (Pl. viii, figs. 1, 2.)

Shell elongately oblong, somewhat curved, solid, covered with a chocolate coloured, laminiferous periostracum, both valves concentrically striate; umbones large, but not prominent, somewhat coarsely corrugate; dorsal margin slightly arched; ventral margin curvedly excavated in the median posterior region; anterior side somewhat produced, rounded above, sloping below; posterior

side produced, rounded; cardinal teeth rather anteriorly situate, triangular, erect; lateral teeth anteriorly very short, posteriorly elongate and abruptly terminating; anterior adductor scars deeply impressed; posterior scars slight; interior of shell very slightly iridescent, sculptured with fine irregular ridges somewhat resembling the marks of coarse finger prints.

Long. 45, lat. 86 mm.

Hab.—River Tigris, Reg. No. [illegible] [Type].

20. **Unio mongolicus,** Middendorff, Sib. Reise, II, 1851 p. 277, pl. xxvii, figs. 7, 8.

Upper Indus, Reg. No. [illegible].

21. **Unio tigridis,** Bourguignat, Test. Nov. Saul., 1852, p. 30 Cat. Rais. Moll., 1853, p. 77, pl. iv, figs. 7, 9,=*Unio truncatus*, Swainson, Zool. Ill., 2nd Ser., I, 1829, pl. x,=*Margarita* (*Unio*) *truncatus*, Lea, Syn., 1836, p. 21; 1838, p. 18,=*Margaron* (*Unio*) *truncatus*, Lea, Syn., 1852, p. 26; 1870, p. 39,=*Unio dignatus*, Lea, Proc. Ac. Nat. Sci. Philad., VII, 1863, p. 189; Jl. Ac. Nat. Sci. Philad., VI, 1866, p. 51, pl. xvii, fig. 48,=*Margaron* (*Unio*) *dignatus*, Lea, Syn., 1870, p. 39,=*Margaron* (*Unio*) *tigris*, Lea, Syn., 1870, p. 39,=? *Unio kisonis*, Kobelt, Icon., 1st sup., 1895, p. 17, pl. vii, figs. 2, 3.

River Tigris, Asiatic Turkey, Reg. No. [illegible].

22. **Unio terminalis,** Bourguignat, Test. Noviss., 1852, p. 31; Cat. Rais. Moll., 1853, p. 76, pl. iii, figs. 4—6 etc.,=*Margaron* (*Unio*) *terminalis*, Lea, Syn., 1870, p. 39.

Jordan Valley, Reg. No. [illegible].

23. **Unio ascia,** Hanley, Rec. Biv. Shells, 1856, p. 385. pl. xxiii, fig. 20.

Penang, Reg. No. [illegible].

24. **Unio perakensis,** sp. n. (Pl. viii, figs. 5, 6.)

Shell closely allied to *Unio pressirostris*,[1] Von Martens, of which it may ultimately prove to be a variety, but differing from that species in its less cuneate form and larger size, in its less contracted anterior side and more obtuse and sloping posterior side.

Long. 31, lat. 85·5, diam. 21 mm.

Hab.—Perak, Reg. No. [illegible] [Type].

Gen. **Shistodesmus,** Simpson, 1900.

25. **Shistodesmus lampreyanus** (Baird and Adams), Simpson, Syn. Naides, Proc. U. S. Nat. Mus., XXII, p. 804,=*Unio* (*Dysnomia*) *lampreyanus*, Baird and Adams, Proc. Zool. Soc. London, 1867, p. 491, pl. xxvi, figs. 2, 2*a*, *Margaron* (*Unio*) *lampreyanus* Lea, Syn., 1870, p. 30

Shanghai, Reg. No. [illegible].

[1] Nachrichtsbl. d. D. Malak. Ges., 1900, p. 14.

Subfam. *HYRINAE*, Swainson.

Gen. **Nodularia**, Conrad, 1853.

Sec. LANCEOLARIA, Conrad, 1853.

26. **Nodularia (Lanceolaria) oxyrynchus** (Mart.), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 807,=*Unio oxyrynchus*, Martens, Mal. Blatt. VII, 1861, p. 57; Kobelt, Abh. Senck. Nat. Ges. XL, 1879, p. 420, pl. xiii, figs. 3, 4.

Japan, Reg. No. $\frac{5229}{1}$.

Sec. NODULARIA, Conrad, 1853.

27. **Nodularia (Nodularia) douglasiae** (Gray), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 808; Griff. An. King. XII, 1833, (p. 601, index 1834), pl. xxi, fig. 2,=*Unio murchisonianus*, Lea, Tr. Am. Phil. Soc., V, 1834, p. 33, pl. iii, fig. 6; Obs., I, 1834, p. 145, pl. iii, fig. 6,=*Margarita* (*Unio*) *murchisonianus*, Lea, Syn., 1836, p. 14; 1838, p. 14,=*Margaron* (*Unio*) *murchisonianus*, Lea, Syn., 1852, p. 21; 1870, p. 32,=*Unio osbecki*, Phil. Zeits. für Mal., 1845, p. 164; Conch., III, Pt. II, p. 45, pl. iii, fig. 1,=*Margaron* (*Unio*) *osbecki*, Lea, Syn., 1852, p. 21; 1870, p. 32,=*Unio nux-persicus*, Dunker, Zeits. für Mal., 1848, p. 83; Musgrave, Phot. Conch., 1863, pl. i, fig. 10,=*Margaron* (*Unio*) *nux-persicus*, Lea, Syn., 1870, p. 32,=*Unio sculptus*, Deshayes, Bull. Nouv. Arch. Mus., IX, 1873, p. 9, pl. i, figs. 3, 3a,=*Unio dactylinus*, Heude, Conch Fl. Nank., 1885, pl. lxv,= ?*Unio pictorum* var. *longirostris*, West, Kong. sv. vet. Ak. Hand., XIV, No. 12, p. 74,=*Unio schrencki*, West,=*Unio abbreviatus*, West.

Ningpo, China, Reg. No. $\frac{5227}{1}$; Shanghai, Reg. No. $\frac{2361}{1}$; N. China, Reg. No. $\frac{5166}{1}$; China, Reg. No. $\frac{993}{1}$.

27*a*. Var. **shanghaiensis**, Lea,=*Unio shanghaiensis*, Lea, Proc. Ac. Nat. Sci. Philad., III, 1859, p. 153; Jl. Ac. Nat. Sci. Philad., IV, 1860, p. 242, pl. xxxvi, fig. 121.

Shanghai, Reg. No. $\frac{2355}{1}$; Chinkiang, China, Reg. No. $\frac{5226}{1}$.

28. **Nodularia (Nodularia) caerulea** (Lea), Simpson, Syn. Naides, Proc. U.S. Nat. Mus., XXII, p. 811,=*Unio caeruleus*, Lea, Tr. Am. Phil. Soc., IV, p. 95, pl. xiii, fig. 25; Obs., I, p. 105, pl. xiii, fig. 25,=*Margarita* (*Unio*) *caeruleus*, Lea, Syn., 1836, p. 20,=*Margaron* (*Unio*) *caeruleus*, Lea, Syn., 1852, p. 30; 1870, p. 47,=*Unio gerbidoni*, Eydoux, Guer. Mag., 1838, p. 9, pl. cxviii, figs. 2, 2a, 2b; Hanley and Theobald, Conch. Ind., 1876, p. 6, pl. xii, fig. 2,=*Unio substriatus*, Lea, Proc. Ac. Nat. Sci. Philad., VIII, 1856, p. 93; Obs. VI, 1857, p. 20, pl. xxvi, fig. 14,=*Margaron* (*Unio*) *substriatus*, Lea, Syn., 1870, p. 47,=*Unio humilis*, Lea, Proc. Ac. Nat. Sci. Philad., VIII, 1856, p. 93; Obs., VI, 1857, p. 16, pl. xxvi, fig. 10,=*Margaron* (*Unio*) *humilis*, Lea, Syn., 1870, p. 32,=*Unio corrianus*, Küster, Conch. Cab. Unio., 1861, p. 229, pl. lxvii, fig. 5,=*Unio leioma*, Benson, Ann. Mag. Nat. Hist., 1862, p. 192; Hanley and Theobald, Conch. Ind.,

1876, p. 6, pl. xii, fig. 5,=*Unio pilatus*, Lea, Proc. Ac. Nat. Sci., Philad., X 1866, p. 133; Jl. Ac Nat. Sci., Philad., VI, 1868, p. 181, pl. xxxviii, fig. 95,=*Margaron* (*Unio*) *pilatus*, Lea. Syn., 1870, p. 47,=*Unio evitatus*, Lea, Proc. Ac. Nat. Sci., Philad., X, 1868, p. 133; Jl. Ac. Nat. Sci., Philad., VI, 1868, p. 279, pl. xxxviii, fig. 92,=*Margaron* (*Unio*) *cristatus*, Lea, Syn., 1870, p. 47,=*Unio trirostris*, Sowerby, Conch. Icon., XVI, pl. lxv, fig. 331.

Saharanpur, United Provinces, Reg. Nos. 5181/1 and 5180/1; Sind, Reg. Nos. 5179/1 and from a jheel near Rohri, Sukkur Dist., Reg. Nos. 5193/1 and 5194/1; Rajputana, Reg. No. 5051/1; Singpal Garhi, Nepal, Reg. No. 5142/1; Kockh(?) Reg. No. 5097/1; Rampur, Reg No. 5063/1; Calcutta, Reg. Nos. 5176/1, 4713/1 (W. Theobold), 5176/1, 5195/1, 5157/1, 5035/1, 5107/1 (G. Nevill); Beigachia, Calcutta, and Maidan tank (N. Annandale), Reg. Nos. 1735/1, 1713/1 and 1711/1; Siliguri, Reg. No. 1871/1; Patna, Reg. No. 2182/1; Phenchooganj, Central Sylhet, Reg No. 1882/1; Barrack River, Silchar, Reg. No. 1863/1; Darjeeling (R Carter), Reg. No. 5212/1; Ballygunge, near Calcutta, Reg. No. 1010/1; Jamalpur, Reg. No. 5021/1; Sambalpur, Bengal, Reg. No. 5200/1; Bagh, Central India (W. T. Blanford), Reg. No. 5222/1; Nerbudda, Central Provinces (W. T. Blanford), Reg. No. 5203/1; Lower Nerbudda, Central Provinces, Reg. Nos. 5171/1 and Burwani, 5178/1; Hazrapur, Bengal, Reg. No. 5210/1; Rajmahal, Bengal (W. T. Blanford), Reg. No. 5212/1; Manbhoom, Bengal, Reg. Nos. 5177/1 and 5011/1; River Dukkaree, Umballa, Punjab Dist., Reg. No. 5221/1; Bhagulpur, Bengal (Capt. Sherwill), Reg. No. 5211/1; Poonasa, Central India (W. T. Blanford), Reg. No. 5201/1.

28*a*. Var. **gaudichaudii** (Eydoux),=*Unio gaudichaudii*, Eydoux, Mag. de Zool., 1838, Cl. V, p. 10, pl. cxviii, fig. 3,= *Margaron* (*Unio*) *gaudichaudii*, Lea. Syn., 1850, p 32; 1870, p 50.

Dacca, Bengal, Reg. No 5181/1; Bengal (Laidley), Reg. No. 5218/1.

28*b*. Var. **keraudreni** (Eydoux),=*Unio keraudreni*, Eydoux, Mag. de Zool., 1838, Cl. V, p. 8, pl. cxviii, fig. 1,=*Margaron* (*Unio*) *keraudreni*, Lea, Syn., 1852, p. 30; 1870, p. 46.

Damuda, Bengal (W. T. Blanford), Reg. No. 5151/1; Chandernagore, Bengal, Reg No. 5190/1.

29. **Nodularia (Nodularia) shurtleffiana** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 813,=*Unio shurtleffianus*, Lea. Proc. Ac Nat. Sci., Philad., VIII, 1856, p. 94; Obs., VI, p. 22, pl xxvii, fig 17; Jl. Ac. Nat. Sci., Philad., III, p. 302,= *Margaron* (*Unio*) *shurtleffianus*, Lea, Syn., 1870, p. 32.

Myadoung, Burma, Reg. No. 3530/1; Shuaygoomyo, Burma, Reg. No. 3810/1; Putna, Mirzapur Dist., U P. (R. Hodgart), Reg. No. 6091/1; Lucknow (Museum Collector), Reg. No. 1821/1, (S. Kemp) Reg. Nos. 5186/3 and 5187/1.

30. **Nodularia (Nodularia) occata** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 813,=*Unio occatus*, Lea, Proc. Ac. Nat. Sci., Philad., IV, 1860, p. 307; Jl. Ac. Nat. Sci., Philad., VI, 1863, p. 398, pl. l, fig. 304; Obs., X, 1863, p. 34, pl. l,

fig. 304,=*Margaron* (*Unio*) *occatus*, Lea, Syn., 1870, p. 31,=*Unio macilentus*, Benson, Ann. Mag. Nat. Hist., Ser. 3, 1862, p. 187; Hanley and Theobald, Conch. Ind., p. 5, pl. x, figs. 2, 4; p. 62, pl. cliv, fig. 5,=*Unio rugosus*, Hanley and Theobald, Conch. Ind., p. 62, pl. cliv, fig. 3.

Saharanpur, Reg. No. $\frac{2553}{1}$; Phenchooganj, Sylhet, Reg. No. $\frac{5140}{1}$; Barrack River, Cachar, Reg. No. $\frac{5046}{1}$; Cachar, Reg. No. $\frac{2562}{1}$; Myadong, Upper Burma, Reg. No. $\frac{6092}{1}$; North-East Cachar, Reg. No. $\frac{5156}{1}$; Pegu, Burma (W. Theobald), Reg. No. $\frac{6093}{1}$ and $\frac{5188}{1}$; Saharunpur, United Provinces (J. Wood-Mason), Reg. No. $\frac{5207}{1}$; Wurda, Central Provinces (W. T. Blanford), Reg. No. $\frac{6205}{1}$; Bhamo, Upper Burma, Reg. No. $\frac{5198}{1}$; Calcutta (G. Nevill), Reg. No. $\frac{6094}{1}$.

31. **Nodularia (Nodularia) pachysoma** (Benson), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 813,=*Unio pachysoma*, Benson, Ann. Mag. Nat. Hist., X, 1862, p. 186; Hanley and Theobald, Conch. Ind., 1876, p. 6, pl. xii, fig. 1,=*Margaron* (*Unio*) *pachysoma*, Lea, Syn., 1870, p. 63,=*Unio pachystoma*, Paetel, Conch. Sam., III, 1890, p. 162.

Sawaddy, Burma (J. Anderson), Reg. No. $\frac{2115}{1}$; Burma (W. Theobald), Reg. No. $\frac{5155}{1}$; Assam (Robinson), Reg. No. $\frac{5160}{1}$; Irrawaddy (J. Anderson), Reg. No. $\frac{5200}{1}$; Calcutta, Reg. Nos. $\frac{6095}{1}$ and (N. Annandale) $\frac{17142}{1}$; Berhampur (R. E. Lloyd), Reg. No. $\frac{17147}{1}$.

32. **Nodularia (Nodularia) chaudhurii**, sp. n.

Shell small, rather thin, elongately ovate, pale olive, covered with a finely laminiferous periostracum; both valves concentrically striate, sculptured with irregular, minute, nodulous, radiate ridges which appear posteriorly as regular corrugations; umbones small, somewhat prominent; dorsal margin slightly arched; ventral margin straight; anterior side produced, rounded; posterior side bluntly rostrate, abruptly sloping above and below; hinge-teeth elongate, anteriorly projecting; anterior scars deep, roundly triangular; posterior scars scarcely impressed; interior of shell iridescent, nacreous, posteriorly corrugate.

Long. 12·75; lat. 23 mm.

Hab.—Upper Burma, Reg. No. $\frac{2115}{1}$ [Type].

33. **Nodularia (Nodularia) bonneaudi** (Eydoux), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 813,=*Unio bonneaudi*, Eydoux, Mag. de Zool., 1838, pl. 119, figs. 1, 1a; Hanley and Theobald, Cat. L. and F. W. Shells, Brit. Ind., pp. 48, 49; Hanley and Theobald, Conch. Ind., pl. x, fig. 6,=*Margaron* (*Unio*) *bonneaudi*, Lea, Syn., 1852, p. 32; 1870, p. 50.

Pegu Reg. Nos. $\frac{2376}{1}$, $\frac{5101}{1}$, $\frac{2125}{1}$, $\frac{5096}{1}$; Shuaygoomyo, Burma, Reg. Nos $\frac{5170}{1}$ and (W. T. Blanford) $\frac{5216}{1}$; Zayleyman, Upper Burma (J. Anderson), Reg. No. $\frac{5202}{1}$; Cachar, Reg. No. $\frac{5155}{1}$; Bhamo, Reg. Nos. $\frac{5107}{1}$ and (J. Anderson) $\frac{5114}{1}$; Tenasserim (W. T. Blanford), Reg. No. $\frac{5210}{1}$; Myadong, Upper Burma, Reg. Nos.

$\frac{5190}{1}$, $\frac{5233}{1}$; Irrawaddy River at Sagaing (J. Coggin Brown), Reg. Nos. $\frac{4739}{1}$ to $\frac{4741}{1}$.

34. **Nodularia (Nodularia) andersoniana** (Nevill),=*Unio andersonianus*, Nevill, Jl. As. Soc. Beng., XLVI, 1877, p. 40; Yunnan Exp., pl lxxx, fig. 9.

Barrack River, Silchar; Reg. No. $\frac{1870}{1}$; Assam, Reg. No. $\frac{2180}{1}$; Myadong, Upper Burma (J. Anderson), Reg. Nos. $\frac{5192}{1}$ [Type] and $\frac{5217}{1}$, $\frac{5191}{1}$; Siliguri, N. Bengal, Reg. No. $\frac{5225}{1}$.

35. **Nodularia (Nodularia) pugio** (Benson), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 814,=*Unio pugio*, Benson, Ann. Mag. Nat. Hist., Ser. 3, X, p. 193; Sowerby, Conch. Icon., pl. xcv, fig. 516.

Pegu, Reg. Nos. $\frac{5023}{1}$ and (W. Theobald) $\frac{5170}{1}$; Myadong, Upper Burma (J. Anderson), Reg. No. $\frac{5213}{1}$; Sawaddy, Burma, Reg. No. $\frac{5183}{1}$; Tenasserim, Lower Burma (W. T. Blanford), Reg. No. $\frac{5219}{1}$; Zayleyman (J. Anderson), Reg. No. $\frac{5205}{1}$; Arakan, Reg. No. $\frac{5030}{1}$.

36. **Nodularia (Nodularia) crispata** (Gould), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 815,=*Unio crispata*, Gould, Proc. Bost. Soc. Nat. Hist., I, 1843, p. 141; Otia Conch., 1862, p. 191,=*Unio crispatus*, Catlow and Reeve, Conch. Nom., 1845, p. 58; Hanley and Theobald, Conch. Ind., 1876, p. 21, pl. xlv, fig. 1,=*Margaron* (*Unio*) *crispatus*, Lea, Syn., 1870, p. 32,=*Unio scobinatus*, Lea, Proc. Ac. Nat. Sci. Philad., VIII, 1856, p. 93; Obs., VI, 1857, p. 19, pl. xxvi, fig. 13,=*Margaron* (*Unio*) *scobinatus*, Lea, Syn., 1870, p. 32,=*Unio mandarinus*, Morelet, J. de Conch., XII, 1863, p. 159,=*Unio pellis-lacerti*, Morelet, J. de Conch., XIII, 1865, p. 22; Sowerby, Conch. Icon., XVI, 1868, pl. lxxxvi, fig. 457,=*Unio venustus*, Morelet, J. de Conch., XIV, 1866, p. 63,=*Unio oblatus*, Lea, Syn., 1870, p. 64.

Siam, Reg. Nos. $\frac{2732}{1}$ and $\frac{1722}{1}$; Battambang, Cambodia, Reg. No. $\frac{5021}{1}$; Bhamo, Reg. No. $\frac{3856}{1}$.

37. **Nodularia (Nodularia) scobina** (Hanley), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 816,=*Unio scobina*, Hanley, Rec. Biv., p. 382, pl. xxiii, fig. 40; Hanley and Theobald, Cat. L. and F. W. Shells Brit. Ind., p. 49; Hanley and Theobald, Conch. Ind., pl. xlvi, fig. 2.

Sibsagar, Assam (S. E. Peel), Reg. No. $\frac{2751}{1}$.

38. **Nodularia (Nodularia) ingallsiana** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 816,=*Unio ingallsianus*, Lea, Tr. Am. Phil. Soc., X, pl. xxiv, fig. 41; Obs., V, 1852, p. 38, pl. xxiv, fig. 41,=*Margaron* (*Unio*) *ingallsianus*, Lea, Syn., 1852, p. 36; 1870, p. 58.

Cambodia, Reg. No. $\frac{5011}{1}$; Siam. Reg. No. $\frac{2736}{1}$.

39. **Nodularia (Nodularia) pazii** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 816,=*Unio pazii*, Lea, Proc. Ac. Nat. Sci., Philad., VI, 1862, p. 176; Jl. Ac. Nat. Sci., Philad.,

VI, p. 61, pl. xxi, fig. 60; Obs., XI, p. 65, pl. xxi, fig. 60,=*Margaron* (*Unio*) *pazii*, Lea, Syn., 1870, p. 39.

China, Reg. No. $\frac{824}{1}$.

40. **Nodularia (Nodularia) olivaria** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 817,=*Unio olivarius*, Lea, Tr. Am. Phil. Soc., IV, p. 108, pl. xvi, fig. 38; Obs., I, p. 118, pl. xvi, fig. 33; Hanley and Theobald, Conch. Ind., p. 5, pl. x, fig. 1,=*Margarita* (*Unio*) *olivarius*, Lea, Syn., 1836, p. 26; 1838, p. 20; 1852, p. 30; 1870, p. 47,=*Unio pumilio*, Küster, Conch. Cab. Unio, 1862, p. 268, pl. xc, fig. 7.

Assam, Reg. Nos. $\frac{2472}{1}$, $\frac{5159}{1}$; Saharanpur, Reg. Nos. $\frac{2445}{1}$ and $\frac{5221}{1}$; East Cachar (Museum Collector), Reg. No. $\frac{5206}{1}$; Moradabad, United Provinces (Laidlay), Reg. No. $\frac{5180}{1}$; North-East Cachar, Reg. No. $\frac{6097}{1}$; Raniganj, Bengal, Reg. No. $\frac{5188}{1}$.

41. **Nodularia (Nodularia) theobaldi** (Nevill, MS.), sp. n.

Shell ovately rectangular, very slightly curved, gaping anteriorly, moderately solid, concentrically striate, covered with a dark, olivaceous periostracum; umbones small, not prominent; dorsal margin somewhat arched, ventral margin slightly excavated in the median region, otherwise straight; anterior side slightly produced and somewhat sharply rounded; posterior side very obtusely rostrate, steeply sloping above, then sharply rounded and again sloping inwards below. Cardinal teeth in right valve roughly triangular, jagged, somewhat inwardly projecting, fitting between two teeth in the left valve which are roughened and of which the anterior is rather broad and massive; lateral teeth in both valves elongate and nearly straight; anterior scars somewhat deeply excavated especially above; posterior scars ovate, lightly impressed; interior of shell nacreous, shading from pale flesh colour to bluish iridescent especially towards the posterior margin.

Long. 34, lat. 60, diam. 19 mm.

Hab.—Manipur, Assam, Reg. Nos. $\frac{1710}{1}$ [Type], $\frac{2178}{1}$.

42. **Nodularia (Nodularia) pecten**, sp. n. (Pl. viii, figs. 3, 4.)

Shell elongately ovate, rather thin, covered with a finely laminiferous periostracum of a pale bluish green colour shading to yellowish green towards the margins, finely concentrically striate and posteriorly ribbed, especially on the left valve; umbones rather small, moderately prominent; dorsal margin very slightly arched; ventral margin gently curved; anterior side rounded; posterior side obtusely rostrate below, sloping above; hinge-teeth in both valves weak, anteriorly erect in right valve, sinuous and almost twisted in the left; posterior teeth nearly straight, moderately elongate; adductor scars scarcely perceptible; interior of shell pearly.

Long. 19, lat. 33·5, diam. 12 mm.

Hab.—Pitsanuloke, N. Siam, Reg. No. $\frac{8064}{1}$ [Type].

The author follows Simpson in placing this and the next two species in the Section *Nodularia*, though, owing to the very

different texture of the shells, it is somewhat difficult to understand his reasons for so placing them.

43. **Nodularia (Nodularia) nuttalliana** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 817,=*Unio nuttallianus*, Lea, Proc. Ac. Nat Sci., Philad., VIII, 1856, p. 103; Obs., VI, 1857, p. 30, pl. xxx, fig. 25; Jl. Ac. Nat. Sci., Philad., 1858, Ser. 2, III, p. 310, pl. xxx, fig. 25; Hanley and Theobald, Conch. Ind., p. 19, pl. xli, figs. 5, 6,=*Margaron* (*Unio*) *nuttallianus*, Lea, Syn., 1870, p. 74.

Assam, Reg. No. $\frac{5230}{1}$; Cachar, Reg. No. $\frac{5180}{1}$.

44. **Nodularia (Nodularia) involuta** (Benson), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 817,=*Unio involutus*, (Benson), Hanley, Rec. Biv. Shells, 1856, p. 385, pl. xxiii, fig. 19; Hanley and Theobald, Conch. Ind., p. 19, pl. xli, fig. 2.

Sylhet, Reg. No. $\frac{5187}{1}$.

Sec. RADIATULA, Simpson, 1900.

45. **Nodularia (Radiatula) crispisulcata** (Benson), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 820,=*Unio crispisulcatus*, Lea, Ann. Mag. Nat. Hist., X, 1862, p. 193; Sowerby, Conch. Icon., XVI, 1866, pl. xlix, fig. 262,=*Margaron* (*Unio*) *crispisulcatus*, Lea, Syn., 1870, p. 149.

Irrawaddy near Thayetmyo (Asiatic Society of Bengal), Reg. No. $\frac{2357}{1}$; Pegu (J. Anderson), Reg. No. $\frac{1717}{1}$; Pegu, Reg. No. $\frac{5182}{1}$; Pegu, Reg. No. $\frac{6098}{1}$.

46. **Nodularia (Radiatula) lima**, Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 820,=*Unio radula* (Benson), Hanley, Rec. Biv. Shells, Supp., 1856, p. 382, pl. xxiii, fig. 41; Hanley and Theobald, Conch. Ind., p. 5, pl. x, fig. 3,=*Dysonomia radula*, Rochebrune, Bull. Soc. Phil., VI, 1882, p. 42.

Siliguri, N. Bengal, Reg. Nos. $\frac{2360}{1}$, $\frac{1735}{1}$, $\frac{3862}{1}$; Sikkim, Reg. No. $\frac{2420}{1}$.

46*a*. Var. **siliguriensis**, Preston,=*Unio siliguriensis*, Preston, Rec. Ind. Mus., Calcutta, II, Pt. 1, p. 47.

Siliguri, Reg. No. $\frac{6029}{1}$. [Type.]

Having now had an opportunity of examining a good series of *N. lima*, a shell which had previously been inaccessible to me, I have no hesitation in reducing *U. siliguriensis* to a variety of that species.

Gen. **Physunio**, Simpson, 1900.

Sec. PHYSUNIO, Simpson, 1900.

47. **Physunio (Physunio) gravidus** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 830,=*Unio gravidus*, Lea, Proc. Ac. Nat. Sci., Philad., VIII, 1856, p. 93; Obs., VI, 1857, p. 12, pl. xxiv, fig. 5; Jl. Ac. Nat. Sci., Philad., III, 1858, p. 292, pl. xxiv, fig. 5,=*Margaron* (*Unio*) *gravidus*, Lea, Syn., 1870, p. 28,=*Lampsilis gravidus*, Rochebrune, Bull. Soc. Phil, VI,

1882, p. 43,=*Unio abnormis*, Morelet, Rev. et Mag., XIV, 1862, p. 480,=*Unio superbus*, Sowerby, Conch. Icon., XVI, pl. lix, fig. 295.

Cambodia, Reg. No. $\frac{10093}{1}$; Siam, Reg. No. $\frac{2577}{1}$; Pitsanuloke, N. Siam (H. W. Biggie), Reg. No. $\frac{1110}{1}$.

48. **Physunio (Physunio) micropterus** (Morelet), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 831,=*Unio micropterus*, Morelet, J. de Conch., XIV, 1866, p. 63; Ser. Conch., IV, 1875, p. 349, pl. xv, fig. 7.

Cambodia, Reg. No. $\frac{10097}{1}$.

Gen. **Dalliella**, Simpson, 1900.

49. **Daliella purpurea** (Valenciennes), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 832,=*Anodonta purpurea*, Valenciennes, Rec. Obs. Zool., II, 1853, p. 236, pl. xlviii *bis*, figs. 3, 3*a*, 3*b*,=*Margarita* (*Anodonta*) *purpurea*, Lea, Syn., 1836, p. 51; 1838, p. 30,=*Anodon purpurea*, Catlow and Reeve, Conch. Nom., 1845, p. 67,=*Margaron* (*Anodonta*) *purpurea*, Lea, Syn., 1852, p. 50; 1870, p. 79,=*Anodonta burroughiana*, Lea, Tr. Am. Phil. Soc., V, 1834, p. 105, pl. xvi, fig. 49; Obs., I, 1834, p. 217, pl. xvi, fig. 49=*Margaron* (*Anodonta*) *burroughiana*, Lea, Syn., 1870, p. 81,=*Anodon burroughianus*, Sowerby, Conch. Icon., XVII, pl. xxvii, fig. 103,=*Margarita* (*Unio*) *bengalensis*, Lea, Syn., 1836, p. 26; 1838, p. 20,=*Unio bengalensis* Lea Tr. Am. Phil. Soc., VI, 1838, p. 3, pl. ii fig. 3; Obs., II, 1838 p. 3, pl. ii, fig. 3,=*Margaron* (*Unio*) *bengalensis* Lea, Syn., 1852, p. 30; 1870, p. 47,=*Anodon bengalensis*, Sowerby, Conch. Icon., XVII, pl. xiv, fig. 49,=*Anodonta bengalensis*, Clessin, Conch Cab. Ano., 1876, p. 173, pl. lvii, fig. 1,=*Unio verecundus* Gould, Proc. Bost. Soc. Nat. Hist., III, 1850, p. 295; U. S. Expl. Exp., XII, 1852, p. 431, figs. 541, 541*a*, 541*b*, 541*c*,=*Unio mauritianus*, Lea, Proc. Ac. Nat. Sci. Philad., III, 1859, p. 152; Jl. Ac. Nat. Sci., Philad., IV, 1860, p. 257, pl. xl, fig. 138,=*Margaron* (*Unio*) *mauritianus*, Lea, Syn., 1870, p. 42,=?*Anodonta heldii*, Küster, Conch. Cab. Ano., 1873, p. 64, pl. xix, fig. 1 =*Anodonta chinensis*, Küster?

Manila, Reg. Nos. $\frac{5027}{1}$, $\frac{5028}{1}$, $\frac{5029}{1}$; Luzon, Reg. No. $\frac{5061}{1}$.

50. **Dalliella subcrassa** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 833,=*Anodonta subcrassa*, Lea, Proc. Zool. Soc., London, 1850, p. 198; Ann. Mag. Nat. Hist., VIII, 1851, p. 495; Jl. Ac. Nat. Sci., Philad., IV, 1859, p. 236, pl. xxxiii, fig. 115,=*Margaron* (*Anodonta*) *subcrassa*, Lea, Syn., 1852, p. 51; 1870, p. 81,=*Anodon subcrassa*, Sowerby, Conch. Icon., XVII, 1867, pl. xiii, fig. 42.

Philippines, Reg. No. [illegible].

51. **Dalliella insularis** (Drouet), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 834,=*Pseudodon insularis*, Drouet, Rev. Biol. Fr., VI, 1894, p. 217 fig 2.

Sarawak, Reg. No [illegible].

Gen. **Pseudodon,** Gould, 1844.

Sec. TRIGONODON, Conrad, 1865.

52. **Pseudodon (Trigonodon) crebristriatus** (Anthony), Simpson, Syn Naiades, Proc. U. S. Nat. Mus., XXII, p. 835,=*Monocondylaea crebristriata*, Anthony, Am. Jl. Conch., I, 1865, p. 205, pl. xviii, fig. 1,=*Trigonodon crebristriata*, Conrad, Am. Jl. Conch., I, 1865, p. 233,=*Margaron* (*Monocondylaea*) *crebristriata*, Lea, Syn., 1870, p. 72,=*Unio crebristriatus*, Sowerby Conch. Icon., XVI, 1868, pl. xcv, fig. 517,=*Pseudodon crebristriatum*, Hanley and Theobald, Conch. Ind., p. 5, pl. ix, fig. 3,=*Unio vondembuschi*, Sowerby Conch. Icon., XVI, pl. xcv, fig. 518.

Pegu, Reg. Nos. [illegible] and [illegible].

52*a*. Var. **curvata,** var. n.

Shell having the ventral margin more curved, and generally less ovate in shape than in the typical form.

Hab.—Pegu, Reg. Nos. [illegible] [Type], [illegible].

52*b*. Var. **peguensis** (Anthony),=*Monocondylaea peguensis*, Anthony, Am. Jl. Conch., I, 1865, p. 205, pl. xviii, fig. 2,=*Margaron* (*Monocondylaea*) *peguensis*, Lea, Syn., 1870, p. 73,=*Pseudodon crebristriatum* var. *peguensis*, Hanley and Theobald, Conch. Ind., 1876, p. 5, pl. ix, fig. 5.

Zayleyman, Reg. No. [illegible].

Sec. PSEUDODON, Gould, 1884.

53. **Pseudodon (Pseudodon) vondembuschiana** (Lea), Conrad, Am. Jl. Conch., I, 1865, p. 233,=*Margaritana vondembuschiana*, Lea, Proc Am. Phil Soc., I, 1840, p. 288; Tr. Am. Phil. Soc., VIII, 1842, pl. xviii, fig. 39; Obs., III, 1842, p. 60, pl. xviii, fig. 39,=*Margaron* (*Monocondylaea*) *vondembuschiana*, Lea, Syn., 1852, p. 45; 1870, p. 73,=*Monocondylaea vondembuschiana*, H. and A. Adams, Gen. Rec. Moll., II, 1858, p. 501, =*Monodontina buschiana*, Conrad, Proc. Ac. Nat. Sci., Philad., VI 1853, pp. 269, 449,=*Unio vonbuschea*, Sowerby, Conch. Icon., XVI, 1866, pl. li, fig. 269,=*Alasmodonta crispata*, Mousson, L. and Süss. W. Moll. Java, 1849, p. 97, pl. xviii, figs. 1, 2,=*Margaritana crispata*, Paetel, Conch. Sam., III, 1890, p. 173,=*Monocondylaea planulata*, Lea. Proc. Ac. Sci., Philad., XI, 1859, p. 187; Jl. Ac. Nat. Sci, Philad., IV, 1859, p. 262, pl. xlii, fig. 142; Obs., VII, 1860, p. 80, pl. xlii, fig. 142,=*Pseudodon planulata*, Conrad, Am. Jl. Conch., I, 1865, p. 233,=*Microcondylaea planulata*, Paetel, Conch. Sam., III. 1890, p. 175,=*Margaron* (*Monocondylaea*) *planulata*. Lea, Syn.. 1870, p. 73,=*Margaritana fragilis*, Küster, Conch. Cab. Unio, 1862, p. 205, pl. xcviii, fig. 2,=*Microcondylaea fragilis*. Paetel, Conch. Sam., III. 1890, p. 175,=*Monocondylaea rhombica*, Küster, Conch. Cab. Unio. 1862, p. 304, pl. c, fig. 7.

Sarawak. Reg. Nos., $\frac{5019}{1}$, $\frac{5165}{1}$.

54. **Pseudodon (Pseudodon) inoscularis** (Gould), Simpson, Syn. Naiades, Proc. U S. Nat. Mus., XXII, p 837,=*Anodon inoscularis*, Gould, Proc. Bost Soc. Nat. Hist., I, 1844, p. 160; Hanley and Theobald, Conch. Ind., p. 5, pl. ix, fig. 2,=*Margaron* (*Monocondylaea*) *inoscularis*, Lea, Syn., 1870, p. 73,=*Margaritana inoscularis*, Paetel, Conch. Sam., 1890, III, p. 173.

Tenasserim River, Reg. No. [illegible]; Tenasserim, Reg. No. [illegible].

55 **Pseudodon (Pseudodon) cumingii** (Lea), Conrad, Am. Jl. Conch, I, 1865, p 233,=*Anondonta cumingii*, Lea, Proc. Zool. Soc., London, 1850, p. 199; Ann. Mag. Nat. Hist., VIII, 1851, p. 495; Musgrave in Hanley's Phot Conch., 1863, pl i, fig. 6,=*Margaron* (*Monocondylaea*) *cumingii*, Lea, Syn., 1852, p. 50, 1870, p. 73,=*Monocondylaea cumingii*, Lea, Jl. Ac. Nat Sci., Philad., IV, 1860, p. 235, pl. xxxiii, fig. 114; Obs., VII, 1860, p. 53, pl. xxxiii, fig. 114,=*Anodon cumingii*, Reeve, Conch. Icon., XVII, 1870, pl. xxxi, fig. 122,=*Microcondylaea cumingii*, Clessin, Conch. Cab. Ano., 1876, p. 239; pl. lxxxiii, figs. 3, 4,=*Pseudodus cumingii*, de Morgan, Bull. Soc. Zool. de Fr., X, 1885, p. 422

Cambodia, Reg. Nos. [illegible] and [illegible]; Philippines (W. Theobald), Reg. No. [illegible].

56. **Pseudodon (Pseudodon) tumidus** (Morelet), Simpson, Syn. Naiades, Proc. U.S. Nat Mus., XXII, p 837,=*Monocondylus tumidus*, Morelet, Jl. de, Conch., XIV, 1866, p. 62; Mabille, Rev. Zool., XXIII, 1872, p. 51, pl. v, figs 6, 7.

Upper Cambodia, Reg. No. [illegible].

57. **Pseudodon (Pseudodon) salwenianus** (Gould), Conrad, Am. Jl. Conch., I, 1865, p. 233,=*Anodon salwenianus*, Gould, Proc. Bost. Soc. Nat. Hist., I, 1844, p. 160,=*Anodonta salweniana*, Gould, Otia Conch., 1862, p. 193,=*Monocondylaea salweniana*, Paetel, Conch. Sam., III, 1890, p. 174,=*Unio salweniana*, Sowerby, Conch. Icon., XVI, 1868, pl. xciv, fig. 513,=*Margaron* (*Monocondylaea*) *salweniana*, Lea, Syn., 1870, p. 72,=*Pseudodon salwenianum*, Hanley and Theobald, Conch. Ind., p. 5, pl. ix, fig. 4.

Tenasserim River, Reg. Nos. [illegible], [illegible] and [illegible]; Burma, Reg. Nos. [illegible] and [illegible]

58. **Pseudodon (Pseudodon) cambodjensis** (Petit), Conrad, Am. Jl. Conch., I, 1865, p. 233,=*Monocondylaea cambodjensis*, Petit, Jl. de Conch., VI, 1865, p. 122,=*Margaron* (*Monocondylaea*) *cambodjensis*, Lea, Syn., 1870, p. 72.

Cambodia, Battambang, Reg. No. [illegible]; Cochin China, Reg. No. [illegible].

59. **Pseudodon (Pseudodon) ava** (Theobald), Simpson, Syn., Naiades, Proc. U.S. Nat. Mus., XXII, p. 839,=*Monocondylaea ava*, Theobald, Jl. As. Soc. Beng., XLII, 1873, pt. II, p. 209, pl. xvii, fig. 15.

Mandalay (J. Anderson), Reg. No. [illegible].

Gen. Parreysia, Conrad, 1853.

Subgen. Parreysia, Conrad, 1853.

60. **Parreysia corrugata** (Müller), Simpson. Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p 841,=*Mya corrugata*, Müller, Verm. Terr. et Fluv., 1774, Pt. 2, p. 214; Besch. Ges. Nat. Ber., IV, 1779, p. 56, pl. iiib, figs. 7, 8,=*Unio corrugata*, Lamarck, An. sans Vert, VI, 1819, p 79; Deshayes, Enc. Méth., II, 1827, p. 584, pl. ccxlviii, fig. 8,=*Unio* (*Potamida*) *corrugata*, Swainson, Tr. on Mal., 1840, p. 268, fig 51; p. 281, fig. 57,=*Unio rugosus*, Küster, Conch. Cab. Unio., 1862, p. 290, pl. xcvii, fig. 5,=*Unio corrugata*, Retzius, Diss. Hist. Nat., 1778, p. 18; Spengler, Skriv. Selsk. Nat., III, 1793, p. 68; Hanley, Test. Moll., 1842, p. 197; Biv. Shells, 1843, p. 197; Hanley and Theobald, Conch. Ind., 1876, p. 21, pl. xlv, figs. 2–5, etc.,=*Margarita* (*Unio*) *corrugatus*, Lea, Syn., 1836, p. 29; 1838, p. 21,=*Margaron* (*Unio*) *corrugatus*, Lea, Syn., 1852, p. 20; 1870, p. 30,=*Mya spuria*, Gmelin, Syst. Nat., 13th Ed., 1788, p. 3222,=*Mya gaditana*, Schreibers, Versuch., 1793,=*Unio multidentatus*, Philippi, Conch., III, 1847, p. 46, pl. iii, fig. 4,=*Margaron* (*Unio*) *multidentatus*, Lea, Syn., 1870, p. 50,=*Unio fulmineus*, Philippi, Conch, III, 1847, p. 46, pl. iii, figs. 5, 6,=*Unio lutens*, Lea, Proc. Ac. Nat. Sci. Philad., VIII, 1856, p. 93,=*Unio luteus*, Lea, Jl. Ac. Nat. Sci. Philad., III, 1857, p. 291, pl. xxiv, fig. 4,=*Margaron* (*Unio*) *luteus*, Lea Syn, 1870, p. 46,= ?*Unio semirugatus*, Chemnitz, Ill. Conch., 1858 pl. xii, figs. 2, 2*a*,=*Unio merodabensis*, Küster, Conch. Cab Unio, 1861, p. 233, pl. lxxviii, fig. 4,=*Unio tennenti*, Hanley and Theobald, Conch. Ind., p. 22, pl. xlv, figs. 7–9.

Garchiroti Tahsil, Chanda, C. P., Reg. No. $\frac{5114}{1}$; River Dukkaree, near Umballa, Reg. No. $\frac{5115}{1}$; Ceylon (Asiatic Society of Bengal), Reg. No. $\frac{2509}{1}$; Séwan, close to the Indus, Reg. No. 2514; Gudur, Madras Presidency (G. H. Tipper), Reg. No. 5113, and a stream two miles north of Gudur (G. H. Tipper), Reg. Nos. $\frac{5112}{1}$ and $\frac{5111}{1}$; Madras, Reg. No. $\frac{2103}{1}$; Manbhoom, Reg. No. $\frac{2506}{1}$; Patna, Reg. Nos. $\frac{2163}{1}$ and $\frac{2507}{1}$; Berhampore, Murshidabad Dist., (S. W. Kemp), Reg. No. $\frac{5057}{1}$; Brahmapuri Tahsil, Chanda, C. P., Reg. No. $\frac{5111}{1}$; Bangalore, Mysore State, Reg. No. $\frac{2171}{1}$; Phenchooganj, Sylhet, Reg. No. $\frac{3089}{1}$; Loc.? (Asiatic Society of Bengal), Reg. No $\frac{2550}{1}$; Singpal Garki, Nepal (R. Hodgart), $\frac{6098}{1}$ Arrah, Reg. No. $\frac{1861}{1}$; Orissa, Reg. No. $\frac{2518}{1}$; Muzafferpore (I. H. Burkill), Reg. No. $\frac{5111}{1}$; Puri, Orissa, Reg. No. $\frac{2515}{1}$; Putna, Mirzapur Dist., U.P. (R Hodgart), Reg. No. $\frac{6100}{1}$.

60*a*. Var. **fragilis**, Hanley and Theobald, Conch. Ind., p. 21, pl. xlv, fig. 4.

Puri, Orissa, Reg. No. $\frac{2515}{1}$.

60*b*. Var. **laevirostris** (Benson), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 842,=*Unio laevirostris*, Benson, Ann. Mag. Nat. Hist., 1862, p. 192; Jl. As. Soc. Beng., 1862,

XXXV, p. 144,=*Unio corrugatus* var. *laevircstris*, Hanley and Theobald, Conch. Ind., 1876, p. 21, pl. xliv, figs. 5, 6.

Chittagong Hills, Reg. Nos. $\frac{2514}{1}$ and $\frac{2194}{1}$; Sadya, N. E. Assam, Reg. No. $\frac{2188}{1}$; Loc. ? (Asiatic Society of Bengal), Reg. No. $\frac{2500}{1}$; Arrah, Reg. No. $\frac{6101}{1}$.

60c. Var. **nagpoorensis** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 842; Hanley and Theobald, Conch. Ind., p. 21, pl. xlv, fig. 3,=*Unio nagpoorensis*, Lea, Proc. Ac. Nat. Sci., Philad., 1859 (1860), p. 331; Jl. Ac. Nat. Sci., Philad., IV, 1860, p. 270, pl. xlv, fig. 150; Obs., VII, 1860, p. 88, pl. xlv, fig. 150,=*Margaron* (*Unio*) *nagpoorensis*, Lea, Syn., 1870, p. 38.

Poona, Reg. No. $\frac{3015}{1}$; a stream two miles north of Gudur, Madras Presidency (G. H. Tipper), Reg. No. $\frac{3111}{1}$; Godavery River, Reg. No. $\frac{2168}{1}$.

61. **Parreysia wynegungaensis** (Lea), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 842,=*Unio wynegungaensis*, Lea, Proc. Ac. Nat. Sci., Philad., 1859 (1860), p. 331; Obs. Unio., VII, p. 89, pl. xlv, fig. 151; Sowerby, Conch. Icon., Unio., pl. xvi, fig. 339,=*Unio wynegungaensis*, Hanley and Theobald, Cat. L. and F. W. Shells Brit. Ind.,=*Margaron* (*Unio*) *wynegungaensis*, Lea, Syn., 1870, p. 50.

Ortalai River, Reg. No. $\frac{2521}{1}$; Damuda (W. T. Blanford), Reg. No. $\frac{2161}{1}$; Surat, Reg. No $\frac{2177}{1}$; Sambalpur, Reg. No. $\frac{2182}{1}$; Godavery River (W. T. Blanford), Reg. Nos. $\frac{1711}{1}$, $\frac{2167}{1}$; from the little 'nuddy' at Barod, about 130 miles S.W. of Sepree, Reg. No. $\frac{5103}{1}$; Assam (*ex coll.* Robinson), Reg. No. $\frac{2551}{1}$.

62. **Parreysia favidens** (Benson), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 842,=*Mya spuria*, Wood, Ind. Test., 1825, p. 12, pl. ii, fig. 35*a*,=*Unio favidens*, Benson, Ann. Mag. Nat. Hist., X, 1862, p 188; Hanley and Theobald, Conch. Ind., 1876, p. 6, pl. xi, fig. 1,=*Margaron* (*Unio*) *favidens*, Lea, Syn., 1870, p. 38,=*Unio favidens*, Paetel, Conch. Sam., III, 1890, p. 152,=*Unio trirostris*, Musgrave in Hanley's Phot. Conch., 1863, pl. ii, fig. 9,=*Unio tripartitus*, Lea, Proc. Ac. Nat. Sci., Philad., VII, 1863, p. 190; Jl. Ac Nat. Sci., Philad., VI, p. 57, pl. xix, fig. 55,=*Margaron* (*Unio*) *tripartitus*, Lea, Syn., 1870, p. 35,=*Unio favidens* var. *marcens*, Benson, Ann. Mag. Nat. Hist., X, 1862, p. 188,=*Unio marcens*, Hanley and Theobald, Conch. Ind., 1876, p 19, pl. xlii, figs. 4—6.

Moradabad (Asiatic Society of Bengal), Reg. No $\frac{2176}{1}$; River Indus, Reg. No. $\frac{2110}{1}$; Barrack River, Silchar, Reg. Nos. $\frac{1867}{1}$, $\frac{1872}{1}$, $\frac{1873}{1}$, $\frac{2187}{1}$; Rajputana, Reg. No. $\frac{2191}{1}$; Berhampur, Reg. No. $\frac{2186}{1}$; Dacca, Reg Nos. $\frac{1197}{1}$ and $\frac{2501}{1}$; Bengal, Reg. No. $\frac{2337}{1}$; Loc. ? (Asiatic Society of Bengal), Reg No. $\frac{2520}{1}$; Cachar, Reg. No. $\frac{2199}{1}$; E. Cachar, Reg. Nos. $\frac{2317}{1}$, $\frac{2309}{1}$, $\frac{2191}{1}$; Barrack River, Sylhet, Reg. No $\frac{2187}{1}$; Tezpur, Reg Nos. $\frac{2301}{1}$ and [illegible]; "West of Ranigunge," Reg. No. $\frac{2077}{1}$; Assam, Reg. No. $\frac{2155}{1}$; Poona, Reg. No. $\frac{3072}{1}$; Karnul, Madras, Reg. No. $\frac{2336}{1}$; Calcutta (J. Wood-Mason) Reg.

No. [illegible], also Reg. No. [illegible]; Seven Tanks, Calcutta, Reg. No. [illegible]; Arrah, Reg. Nos. [illegible] and [illegible]; Rajmahal, Reg. No. [illegible]; Hazrapur, Reg. No. [illegible]; Ranigunge, Reg. No. [illegible]; Sunderbunds, Reg. No. [illegible]; Phenchooganj, Central Sylhet (a variety), Reg. No. [illegible].

62*a*. Var. **pinax** (Benson). Hanley and Theobald, Conch. Ind., p. 6, pl. x, fig. 2,=*Unio pinax*, Benson, Ann. Mag. Nat. Hist., 1862, p. 192; Jl. As. Soc. Beng., XXXV, 1866, p. 144.

Loc? (Asiatic Society of Bengal), Reg. No. [illegible]; Arrah, Reg. No. [illegible].

62*b*. Var. **plagiosoma** (Benson). Hanley and Theobald, Conch. Ind., p. 6, pl. xi, fig. 3,=*Unio plagiosoma*, Benson, Ann. Mag. Nat. Hist., X, p. 191; Jl. As. Soc. Beng., XXXV, 1866, p. 144.

Patna, Reg. No. [illegible]; Langlai, Assam, Reg. Nos. [illegible] and [illegible]; Alipur, Calcutta (J. Anderson), Reg. No. [illegible]; Birbhum (J. Wood-Mason), Reg. No. [illegible].

62*c*. Var. **chrysis** (Benson), Ann. Mag. Nat. Hist., Ser. 3, X, p. 189; Hanley and Theobald, Conch. Ind., pl. xli, fig. 3.

Patna, Reg. No. [illegible].

62*d*. Var. **deltae** (Benson), Ann. Mag. Nat. Hist., Ser. 3, X, p. 89; Hanley and Theobald, Conch. Ind., pl. xlii, fig. 2.

Hazrapur, Reg. Nos. [illegible] and [illegible]; Calcutta, Reg. No. [illegible].

62*e*. Var. **irridula** (Benson), Ann. Mag. Nat. Hist., Ser. 3, X, p. 189.

Bengal, Reg. No. [illegible]; Damuda, Reg. No. [illegible]; Manbhoom, Reg. No. [illegible]; Gunduk (Asiatic Society of Bengal), Reg. No. [illegible]; Ranigunge, Reg. No. [illegible]; Patna, Reg No. [illegible].

62*f*. Var. **assamensis** (Nevill, MS.), var. n.

Shell more convex than the typical form, the dorsal margin is rather less posteriorly angled, the anterior side more rounded and the posterior slightly more nasute.

Hab.—Digong, Reg. No. [illegible] [Type]; Assam, Reg. Nos. [illegible], [illegible] and [illegible]; Arrah (Asiatic Society of Bengal), Reg. No. [illegible]; Sylhet, Reg. No. [illegible].

63. **Parreysia smaragdites** (Benson).=*Unio smaragdites*, Benson, Ann. Mag. Nat. Hist., 1862, X, p. 190.

Bhamo, Upper Burma (J. Anderson), Reg. Nos. [illegible], [illegible]; Zayleyman Upper Burma (J. Anderson), Reg. No. [illegible]; Zayleyman, Reg. No. [illegible]; Loc? (J. Anderson) Reg. No. [illegible].

64. **Parreysia bhamoensis** (Theobald), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 843,=*Unio bhamoensis*, Theobald, Jl. As. Soc. Beng., XLII, 1873, Pt. 2, p. 207, pl. xvii, fig. 1,=*Unio mandelayensis*, Theobald, Jl As. Soc. Beng., XLII, Pt. 2, p. 208, pl. xvii, fig. 2.

Mandalay, Upper Burma, Reg. Nos. [illegible] and (J. Anderson) [illegible]; Sheinmagah, Upper Burma, Reg. No. [illegible]; Irrawaddy

River at Sagaing (J. Coggin Brown), Reg. Nos. $\frac{1737-38}{1}$; Zayleyman, Upper Burma (J. Anderson), Reg. No. $\frac{2570}{1}$.

65. **Parreysia pernodulosa**, sp. n.

Shell small, ovate, dark brown; both valves sculptured anteriorly with coarse, corrugate ridges which become more nodulous and irregular in the median and posterior regions; umbones rather large; dorsal margin rapidly sloping anteriorly, slightly sloping posteriorly; ventral margin somewhat rounded; anterior side rather contracted, sharply rounded; posterior side broad, very gently rounded; cardinal teeth very anteriorly situate, in right valve squarish, bearing two elongate grooves; in left valve large, jagged, split into three portions, between each of which occur two deep notches, the middle portion, or that between the two notches, being by far the smallest: at the base of the anterior portion is situated a smaller, jagged tooth which is obliquely grooved in the centre; lateral teeth in both valves posteriorly, elongately arched, grooved down the whole length; anterior scars very deep; posterior scars elongate, but not well marked; interior of shell pale bluish, nacreous.

Long. 15·5; lat. 20·5 mm.

Hab. Zayleyman, Upper Burma (J. Anderson), Reg. No. [illegible] [Type].

66. **Parreysia feddeni** (Theobald), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 843;=*Unio feddeni*, Theobald, Jl. As. Soc. Beng., XLII, Pt. 2, p. 208, pl. xvii, fig. 3; Hanley and Theobald, Cat. L. and F. W. Shells, Brit. Ind., p. 48.

Pem Ganga, Reg. No. [illegible] (*ex coll.* W. T. Blanford).

67. **Parreysia daccaensis**, sp. n.

Shell differing from *P. feddeni*, Theobald, in its much larger size, more ponderous form and more elongately ovate shape, it is much darker in colour, being of a dark blackish brown instead of the greenish yellow shade of that species, the shell is much more coarsely, concentrically striate and is also considerably malleated, while *P. feddeni* is almost smooth in texture; the umbones in the present species are, though larger, far less prominent, but the system of hinge teeth is the same.

Long. 47; lat. 76·5, diam. 29 mm.

Hab. Dacca, Reg. No. [illegible] [Type].

68. **Parreysia tavoyensis** (Gould), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 843,=*Unio tavoyensis*, Gould, Proc. Bost. Soc. Nat. Hist., 1843, p. 140; Küster, Conch. Cab. Unio., 1856, p. 166, pl. xlviii, fig. 2, etc.=*Margaron* (*Unio*) *tavoyensis*, Lea, Syn., 1870, p. 31,=*Unio savoyensis* Paetel, Conch. Sam., III, 1890, p. 166,=*Unio parma*, Benson, Sowerby, Conch. Icon., XVI, 1868, pl. xcv, fig. 514; Hanley and Theobald, Conch. Ind., p. 61, pl. cliv, fig. 1.

Tavoy, Reg. Nos. [illegible], [illegible], and [illegible]; Pegu, Reg. Nos. [illegible], $\frac{2567}{1}$, and [illegible]; Arakan, Reg. No. [illegible]; Tenasserim, Burma (W. T. Blanford), Reg. No. [illegible]: Mandalay, Reg. No. [illegible].

68*a*. Var. **triembolus** (Benson), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 844,=*Unio triembolus*, Benson, Jl. As. Soc. Beng., XXXV, 1855, p. 144; Ann. Mag. Nat. Hist., X, 1862, p. 190; Hanley and Theobald, Conch. Ind., p. 43, pl. cvii, fig. 2,=*Unio houngdaranicus*, Tapparone-Canefri, Ann. Mus. Civ. Genova, VII, 1889, p. 341.

Cachar, Reg. No. [illegible]; Barrack River, Silchar, Reg. No. [illegible]; Loc? (Asiatic Society of Bengal), Reg. No. [illegible]; Calcutta, Reg. No. [illegible].

69. **Parreysia rajahensis** (Lea), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 844,=*Unio rajahensis*, Lea, Proc. Am. Phil. Soc., II, 1841, p. 30; Tr. Am. Phil. Soc., VIII, 1842, p. 289, pl. xxiii, fig 53; Obs., III, 1842, p. 77, pl. xxiii, fig. 53,=*Margaron* (*Unio*) *rajahensis*, Lea, Syn., 1852, p. 25; 1870, p. 38, =*Unio indicus*, Sowerby, Conch Icon., XVI, 1866, pl. xl, fig, 222; Hanley and Theobald, Conch. Ind., p. 43, pl. cvii, fig. 1, *Margaron* (*Unio*) *indicus*, Lea, Syn., 1870, p. 31

Nerbudda River, Reg. No. [illegible]; Poona, Reg. No. [illegible]; Nerbudda R. (W. Theobald), Reg. No. [illegible]; Nerbudda R., Reg. No. [illegible], (W. T. Blanford); "from the soil of the Run Kach," Reg. No. [illegible]; from 130 miles S. W. of Sepree, Reg. No. [illegible]; Sahibgunge, Reg. No. [illegible].

70. **Parreysia corbis** (Hanley), Simpson, Syn Naiades, Proc. U. S. Nat. Mus. XXII, p. 845, *Unio corbis*, Benson in Hanley's Rec Biv. Shells, 1856, pl. xxiii, fig. 43; Hanley and Theobald, Conch. Ind., p. 22, pl. xlv, fig. 10, *Margaron* (*Unio*) *corbis*, Lea, Syn., 1870, p. 5[illegible].

Assam, Reg. No [illegible].

71. **Parreysia burmanus** (Blanford), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 845,=*Unio burmanus*, Blanford, Proc. Zool. Soc, London, 1869, p. 450, *Unio birmanus*, Hanley and Theobald, Conch. Ind., p. 19, pl. xlii, fig. 11.

Bhamo, Reg. Nos. [illegible] [Type], [illegible], [illegible], [illegible] (J. Anderson), [illegible].

72. **Parreysia sikkimensis** (Lea), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 845, *Unio sikkimensis*, Lea, Proc. Ac. Nat. Sci. Philad., III, 1850, p. 151; Jl. Acad. Nat Sci., IV, 1859, p. 251; Obs., VII, 1860, p. 69, pl. xxxix, fig. 131,=*Margaron* (*Unio*) *sikkimensis*, Lea, Syn., 1870, p 64.

Sikkim, Reg. No. [illegible]; Sibsagar, Assam, Reg. Nos. [illegible] and [illegible] (S. E. Peal); Siliguri, Reg. No. [illegible]; Namtsik, Dihing, Reg. No. [illegible]; Cachar, Reg. No [illegible].

73. **Parreysia gowhattensis** (Theobald), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 845, *Unio gowhattensis*, Theobald, Jl. As. Soc. Beng., XLII, 1873, Pt. 2, p. 208, pl. xvii, fig. 4.

Gowhatty (=Gauhati), Assam (Museum Collector), Reg. No. [illegible]; Gowhatty, Reg. Nos. [illegible] and [illegible].

74. **Parreysia annandalei**, sp. n.

Shell oval, convex, moderately solid, coarsely concentrically ribbed, covered with a thin, smooth, brownish-olivaceous periostracum; umbones rather small, not prominent; dorsal margin arched; ventral margin considerably rounded; anterior side slightly produced and rather sharply rounded; posterior side very bluntly sub-rostrate; cardinal teeth two in each valve, somewhat anteriorly situate, rather coarse, corrugated; lateral teeth strong, curved; anterior scars rather small, very deeply excavated; posterior scars also small, ovate, deeply impressed; interior of shell whitish, iridescent.

Long. 29, lat. 41, diam. 20 mm.

Hab.—Gowhatty, Reg. No. $\frac{2190}{1}$ [Type].

75. **Parreysia perconvexa**, sp. n.

Shell ovate, slightly curved, very convex, solid, but much eroded, where intact covered with a dark blackish brown periostracum; umbones moderately large; dorsal margin sloping in an anterior direction; ventral margin slightly curved posteriorly; anterior side gently rounded; posterior side slightly and very bluntly produced, rounded; cardinal teeth very anteriorly situate with upper surface multi-ridged and supported in each valve by an enormous column-like callus thickening of the shell; lateral teeth coarse, rather short, curved; anterior muscular scars of great depth; posterior scars subcircular, well impressed; interior of shell very pale greenish white.

Long. 37, lat. 55, diam. 33 mm.

Hab.—Nangyong Lake, Reg. No. $\frac{7060}{1}$ [Type].

Gen. **Lamellidens,** Simpson, 1900.

Subgen. **Lamellidens,** Simpson, 1900.

76. **Lamellidens marginalis** (Lamarck), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 854,=*Unio marginalis*, Lamarck, An. sans Vert., VI, 1819, p. 79; Deshayes, Enc. Méth., II, 1827, p. 151, pl. ccxlvii, fig. 1,=*Die breite Mahler-Muschel aus Grönland*, Schröter, Flusse., 1779, p. 181, pl. ix, fig. 1,=? *Unio groenlandicus*, Mörch, Am. Jl. Conch., IV, 1868, p. 38,=? *Unio testudinarius*, Spengler, Skriv. Selsk. Nat., III, 1793, p. 65,= ?*Unio truncatus*, Spengler, Skriv. Selsk. Nat., III, 1793, p. 65= *Margarita* (*Unio*) *marginalis*, Lea, Syn., 1836, p 37; 1838, p. 24, =*Margaron* (*Unio*) *marginalis*, Lea, Syn., 1852, p. 38; 1870, p. 60,=*Unio anodontina*, Lamarck, An. sans Vert., VI, 1819, p. 80,=*Unio anodontinus*, Küster, Conch, Cab. Unio., 1861, p. 240, pl. lxxx, fig. 15,=*Symphynota bilineata*, Lea, Tr. Am. Phil. Soc., IV, 1831, p. 98, pl. xi, fig. 19; Obs. I, 1834, p. 108, pl. xi, fig. 19,=*Margarita* (*Unio*) *bilineatus*, Lea, Syn., 1836, p. 38; 1838, p. 25,=*Unio bilineatus*, Hanley, Test. Moll., 1842, p. 207: Biv. Shells, 1843, p. 207, pl. xxi, fig. 30,=*Margaron* (*Unio*) *bilineatus*, Lea, Syn., 1852, p. 38; 1870, p. 61,= ?*Unio evanescens*, Mousson, Moll. Java., 1849, p. 91, pl. xvii, fig. 2.

Singbhoom, Reg. No. $\frac{1880}{1}$; Chittagong, Reg. No. $\frac{1877}{1}$; Arrah Reg. No. $\frac{1898}{1}$; Burma, Reg. No. $\frac{2563}{1}$; Hazrapur, Reg. No. $\frac{1579}{1}$; Rangoon, Reg. No. $\frac{5106}{1}$; Bhamo, Upper Burma (J. Anderson), Reg. No. $\frac{2535}{1}$; Tank near Bangalore, Reg. No. $\frac{5012}{1}$; Tezpur, Reg. No. $\frac{2530}{1}$; Dacca, Reg. No. $\frac{1891}{1}$; Toungoo, Burma, Reg. No. $\frac{2137}{1}$; Bhagalpur (Capt. Sherwill), Reg. No. $\frac{1576}{1}$; "a stream two miles north of Guddur, Madras Presidency" (G. H. Tipper), Reg. Nos. $\frac{5110}{1}$, $\frac{5115}{1}$; "from the little 'nuddy' at Barod, S. W. of Sepree, about 130 miles," Reg. Nos. $\frac{5030}{1}$, $\frac{5021}{1}$; "from a jheel near Rohri, Sind," Reg. No. $\frac{1055}{1}$: Irrigation Channels, Seistan, Reg. Nos. $\frac{3211}{1}$ and $\frac{1811}{1}$; Poona, Reg. Nos. $\frac{5098}{1}$ and $\frac{5073}{1}$; Karnul District, Madras, Reg. Nos. $\frac{5017}{1}$ and $\frac{5038}{1}$; Calcutta, Reg. Nos. $\frac{1887}{1}$, $\frac{1886}{1}$ (distorted specimens), $\frac{1896}{1}$ (very young specimens); Belgachia, Calcutta (N. Annandale), Reg. Nos. $\frac{1730}{1}$, $\frac{1732}{1}$; Loc ? (Indian Tanks), Reg. Nos. $\frac{1720}{1}$ and $\frac{5109}{1}$; Patna, Reg. No. $\frac{1900}{1}$; Bandardaha, Berhampur, Bengal (B. L. Chaudhuri), Reg. No. $\frac{5031}{1}$; Silcuri, Reg. No. $\frac{1861}{1}$; Barrack River, Silchar, Reg. No. $\frac{5017}{1}$; E. Cachar, Reg. No. $\frac{1899}{1}$; Igatpuri, Western Ghats (Museum Collector), young specimens, Reg. No. $\frac{1791}{1}$; Putna, Mirzapur District, U. P. (R. Hodgart), Reg. No. $\frac{1750}{1}$.

76*a*. Var. **obesus** (Hanley and Theobald), Simpson, Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 855,=*Unio marginalis* var. *obesa*, Hanley and Theobald, Conch. Ind., p. 20, pl. xliii, fig. 3,= ?*Unio corrianus*, Sowerby, Conch. Icon., XVI, 1868, pl. lxxvii, fig. 41.

Chittagong, Reg. No. $\frac{5031}{1}$; Silchar, Cachar, Reg. No. [illegible]; Toungoo, Burma, Reg. No. $\frac{2520}{1}$.

76*b*. Var. **tricolor** (Hanley and Theobald), Simpson, Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 855,=*Unio tricolor*, Küster, Conch. Cab. Unio., 1856, p. 156, pl. xlv, fig. 1,=*Unio marginalis* var. *tricolor*, Hanley and Theobald, Conch. Ind., p. 20, pl. xliii, fig. 5.

Shuaygoomyo, Reg. No. [illegible]; Manbhoom, Reg. No. [illegible].

76*c*. Var. **candaharicus** (Hutton),=*Lamellidens marginalis* var. *candaharicus* (Hanley and Theobald), in Simpson's Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 855,=*Unio marginalis* var. *candaharica*, Hanley and Theobald, Conch. Ind., p. 20, pl. xliii, fig. 4,=*Unio marginalis* var. *kandaharica*, Hutton, in Theobald's Cat. L. and F. W. Shells, Brit. Ind., p. 46,=*Unio candaharicus*, Hutton, Jl. As. Soc. Beng., XVIII, Pt. 2, 1850, p. 660.

Kandahar (Hutton), Reg. No. [illegible]; Kandahar, Reg. No. $\frac{1723}{1}$.

76*d*. Var. **thwaitesi**, Lea,=*Lamellidens thwaitesi*, Lea, in Simpson's Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 856,=*Unio thwaitesi*, Lea, Proc. Ac. Nat. Sci., Philad., III, 1859, p. 152; Jl. Acad. Nat. Sci., Philad., IV, 1860, p. 246, pl. xxxvii, fig. 125,=*Margaron* (*Unio*) *thwaitesi*, Lea, Syn., 1870, p. 41,=*Unio consobrinus*, Hanley and Theobald, Conch. Icon., p. 19, pl. xli, fig. 7.

Ceylon, Reg. Nos. $\frac{5014}{1}$, $\frac{1718}{1}$; Colombo, Reg. No. [illegible].

76*e*. Var. **consobrinus**, Lea,=*Lamellidens consobrinus*, Lea, in Simpson's Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 856,=*Unio consobrinus*, Lea, Proc. Ac. Nat. Sci., Philad., III, 1859, p. 331; Jl. Ac. Nat. Sci., Philad., 1860, p. 272, pl. xlv, fig. 152; Obs., VII, 1860, p. 90, pl. xlv, fig. 152,=*Margaron* (*Unio*) *consobrinus*, Lea, Syn., 1870, p. 46,=*Unio corbeti*, Deschamps, Bull. Soc. Zool. Fr., XVII, 1892, p. 68, fig.

Assam, Reg. No. [illegible]; Poona, Reg. No. [illegible]; Dacca, Reg. No. [illegible].

76*f*. Var. **lamellatus**, Lea,=*Lamellidens lamellatus*, Lea, in Simpson's Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 856,=*Unio lamellatus*, Lea, Tr. Am. Phil. Soc., VI, 1838, p. 19, pl. vi, fig. 16: Obs., II, 1838, p. 19, pl. vi, fig. 16,=*Margarita* (*Unio*) *lamellatus*, Lea, Syn., 1836, p. 26; 1838, p. 20,=*Margaron* (*Unio*) *lamellatus*, Lea, Syn., 1852, p. 29; 1870, p. 46,=*Unio layardii*, Lea, Proc. Ac. Sci., Philad., III, 1859, p. 153; Jl. Ac. Nat. Sci., Philad., IV, 1860, p. 243, pl. xxxvi, fig. 22,=*Margaron* (*Unio*) *layardii*, Lea, Syn., 1870, p. 46.

Upper Burma, Reg. No. [illegible]; Calcutta, Reg. No. [illegible]; Mandalay, Reg. Nos. [illegible] and [illegible]; Pegu, Reg. No. [illegible]; Bhamo (J. Anderson), Reg. No. [illegible]; Matale, Ceylon, Reg. No. [illegible].

After a careful examination of a long series of this shell the author is unable to consider it other than a mere variety of *L. marginalis*.

76*g*. Var. **scutum**, Sowerby,=*Lamellidens scutum*, Sowerby, in Simpson's Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 857,=*Unio scutum*, Sowerby, Conch. Icon., 1868, XVI, pl. xciv, fig. 510; Hanley and Theobald, Conch. Ind., p. 22, pl. xlvi, fig. 1.

Tenasserim, Burma, Reg. No. [illegible]; Rangoon (N. Annandale), Reg. No. [illegible].

76*h*. Var. **corrianus**, Lea,=*Lamellidens corrianus*, Lea, in Simpson's Syn. Naiades, Proc. U. S. Nat. Mus., XXII, p. 857,=*Unio corrianus*, Lea, Tr. Am. Phil. Soc., VI, 1834, p. 65, pl. ix, fig. 25; Obs., I, 1834, p. 177, pl. ix, fig. 25,=*Margarita* (*Unio*) *corrianus*, Lea, Syn., 1836, p. 38; 1838, p. 25,=*Margaron* (*Unio*) *corrianus*, Lea, Syn., 1852, p. 38; 1870, p. 61.

Sibsagar, Assam (S. E. Peel), Reg. No. [illegible]; Calcutta, Reg. Nos. [illegible], [illegible], [illegible] and [illegible]; Pegu (W. T. Blanford), Reg. Nos. [illegible] and [illegible]; Balagunge, Central Sylhet, Reg. No. [illegible]; Burma, Reg. No. [illegible]; Zayleyman, Upper Burma (J. Anderson), Reg. No. [illegible]; Madras, Reg. No. [illegible]; Berhampur, Murshidabad District, Bengal (S. W. Kemp), Reg. No. [illegible]; Sambalpur, Reg. No. [illegible].

76*i*. Var. **generosus**, Gould,=*Lamellidens generosus* (Gould) in Simpson's Syn. Naiades, Proc. U.S. Nat. Mus., XXII, p. 857,=*Unio generosus*, Gould, Proc. Bost. Soc. Nat. Hist., 1847, p. 220; Hanley and Theobald, Conch. Ind., p. 22, pl. xlvi, fig. 4,=*Unio generosus* var. *angustior*, Hanley and Theobald, Conch. Ind.,

p. 22, pl. xlvi, fig. 7,=*Margaron (Unio) generosus*, Lea, Syn., 1870, p. 29,=?*Unio lamellatus*, Sowerby, Conch. Icon., XVI, 1868, pl. xciv, fig. 511.

Myadong, Upper Burma (J. Anderson), Reg. No. $\frac{2531}{1}$; Mandalay (N. Annandale), Reg. Nos. $\frac{1725}{1}$–26; Bhamo (J. Coggin Brown), Reg. No. $\frac{4730}{1}$.

76*j*. Var. **jenkinsianus** (Benson),=*Lamellidens jenkinsianus*, (Benson) in Simpson's Syn. Naiades, Proc. U S. Nat. Mus., XXII, p. 857,=*Unio jenkinsianus*, Benson, Ann. Mag. Nat. Hist., Ser. 3, X, p. 185; Hanley and Theobald, Conch. Ind., pl. xli, fig. 4.

Upper Assam, Reg. No. $\frac{2116}{1}$; Sylhet, Reg. No. $\frac{5037}{1}$; Upper Bramaputra (F. Stoliczka), Reg. No. $\frac{1571}{1}$; Bhagalpur (Capt. Sherwill), Reg. No. $\frac{1575}{1}$.

76*k*. Var. **zonatus,** Deshayes,=*Unio zonatus*, Deshayes, Enc. Méth. Vers., II, p. 587; Hanley and Theobald, Conch. Ind., pl. xliv, fig. 2.

Rangoon, Reg. No. $\frac{5066}{1}$.

76*l*. Var. **sublamellatus** (Nevill, MS.) var. n.

An elongate, somewhat rostrate form, having the hinge teeth rather less developed.

Hab.—Burma (W. Theobald), Reg. No. $\frac{1711}{1}$ [Type].

76*m*. Var. **sawaddyensis** (Nevill, MS.) var. n.

Shell much more ovate and convex than the typical form, having the dorsal margin more arched and posteriorly ascending, the ventral margin and anterior side more rounded, and the posterior side produced and roundedly rostrate.

Hab.—Sawaddy River (Asiatic Society of Bengal), Reg. No. $\frac{2511}{1}$ [Type]; Bhamo (J. Anderson), Reg. No. $\frac{1701}{1}$; Sawaddy, Tengling Stream (J. Anderson), Reg. Nos $\frac{2528}{1}$ and $\frac{2529}{1}$; Shuaygoomya, Upper Burma (J. Anderson), Reg. No. $\frac{2532}{1}$; Mandalay, Upper Burma (N. Annandale), Reg. Nos. $\frac{1720}{1}$–21.

77. **Lamellidens narainporensis**, sp. n.

Shell cuneate, moderately convex, posteriorly rostrate, dark reddish brown, covered, towards the margins, with a finely laminiferous periostracum, marked with concentric lines of growth, bearing two carinae on each valve running from the umbones in a dorsally posterior direction; umbones small, not prominent, somewhat coarsely corrugated; dorsal margin very gently arched; ventral margin scarcely rounded in the anterior and median regions, slightly curved posteriorly; anterior side abruptly rounded; posterior side sloping above, then angled and very abruptly descending; cardinal tooth in left valve obtusely triangular, erect, absent in right valve; lateral teeth anteriorly short, deeply grooved and projecting in right valve, erect and jagged in the left, posteriorly moderately elongate and bifurcated in both valves; anterior scars rather circular, deep; posterior scars lightly impressed; interior of shell pale flesh colour shading to iridescent bluish white, very minutely granulate.

Long. 35, lat. 84 mm.

Hab. —Narainpore Bhil, Murshidabad District, Bengal (C. J. Robertson Milne), Reg. No. [illegible] [Type].

78. **Lamellidens nongyangensis**, sp. n.

Shell very elongately ovate, inflated, covered with a blackish brown, finely laminiferous periostracum, concentrically marked with rather coarse lines of growth: dorsal margin anteriorly somewhat straight, posteriorly arched above, sloping and slightly excavated below; ventral margin scarcely rounded; anterior side abruptly descending; posterior side rostrate, obtusely rounded; cardinal teeth very anteriorly situate, triangular, erect, lateral teeth elongate, also erect, terminating posteriorly in an abrupt slope; anterior scars deeply marked; posterior scars lightly impressed; interior of shell flesh-coloured shading to bluish, iridescent, minutely pitted and granulate.

Long. 45, lat. 94 mm

Hab. Nongyang Lake, South of Patkai, Reg. No. [illegible] [Type].

79. **Lamellidens phenchooganjensis**, sp. n.

Shell very elongately ovate, posteriorly obtusely rostrate, dark blackish brown, sculptured with fine concentric striae, crossed, especially in the anterior median region, by fine, slightly distant, transverse, radiate striae, thus presenting a minutely wrinkled appearance; umbones flattened, much eroded; dorsal margin anteriorly gently sloping, posteriorly more rapidly sloping in a slight curve, ventral margin scarcely rounded; anterior side angled above, gently rounded below; posterior side produced, angularly rounded; hinge teeth very elongate, somewhat fine; anterior scars ovate, moderately impressed; posterior scars roughly triangular, not well impressed; interior of shell shading from pale brown to bluish, nacreous, marked, especially towards the anterior ventral region, with very shallow radiate furrows.

Long. 42, lat. 86 mm.

Hab. Phenchooganj Central Sylhet, Reg. No. [illegible] [Type].

80. **Lamellidens mainwaringi** (Nevill, MS.) sp. n.

Shell rather small, cuneate, covered with a finely laminiferous periostracum; both valves marked with rather fine, concentric and finer, transverse, radiate, scratch-like striae; dorsal margin anteriorly gradually sloping, posteriorly arched and more rapidly descending; ventral margin somewhat straight; anterior side rounded; posterior side angled above and below, somewhat obliquely and obtusely rostrate; hinge teeth well developed, moderately short; anterior adductor scar deeply impressed, posterior scar somewhat roughly triangular, well impressed; interior of shell bluish iridescent, rather granulate.

Long. 25·5, lat. 50 mm.

Hab. Siliguri, Reg. Nos. [illegible] [Type], [illegible], [illegible]; Namtsik, Dihang, Reg. No. [illegible].

Genus **Trapezoideus**, Simpson, 1900.

81. **Trapezoideus foliaceus** (Gould), Simpson, Syn. Naiades Proc. U. S. Nat. Mus., XXII, p. 858,=*Unio foliacea*, Gould, Proc. Bost. Nat Hist. Soc., I, 1843, p. 141,=*Unio foliaceus*, Catlow and Reeve, Conch. Nom., 1845 p. 59; Hanley and Theobald, Conch. Ind, p. 19, pl. xlii. fig. 3.=*Margaron* (*Unio*) *foliaceus*, Lea, Syn., 1852, p. 39; 1870, p. 62, =*Unio peguensis*, Anthony, Am. Jl. Conch., I, 1865, p. 351. pl. xxv, fig. 2; Sowerby, Conch. Icon., XVI, 1868, pl. xcv. fig. 510,=*Margaron* (*Unio*) *peguensis*. Lea, Syn., 870, p. 51.

Bhamo (J. Anderson), Reg. No. [illegible]; Pegu (W. T. Blanford), Reg. No. [illegible]; Pegu, Reg. No. [illegible].

81*a*. Var. **zayleymanensis** (Nevill, MS.), var. n.

Shell thinner and smaller than the typical form, more pro. duced anteriorly and much more obtuse posteriorly, the slight curve in the ventral margin is also absent.

Hab.- Bhamo (J. Anderson), Reg. No. [illegible] [Type]; also from Bhamo, Reg No. [illegible]; Zayleyman (J. Anderson), Reg. No. [illegible].

82. **Trapezoideus misellus** (Morelet), Simpson, Syn. Naiades, Proc. U.S. Nat Mus., XXII, p. 859,=*Unio misellus*, Morelet, Jl. de Conch, XIII, 1865, p. 21; Ser Conch., IV, 1875, p. 341, pl. xiv, fig. 2,=*Unio siamensis*, Lea, Proc. Ac. Nat. Sci., Philad., X. 1866, p. 133, Jl. Ac. Nat. Sci., Philad., VI, 1868, p. 279, pl. xxxviii. fig. 93; Obs., XII, 1869, p. 39. pl. xxxviii, fig. 93. =*Margaron* (*Unio*) *siamensis*, Lea, Syn., 1870, p. 57.

Tenasserim, Lower Burma, Reg. No. [illegible]; Irrawaddy River at Sagaing (J. Coggin Brown), Reg Nos. [illegible].

82*a*. Var. **subclathratus**, von Martens, Arch. für Naturg., p. 44, pl. vi, fig. 3.

Sheinmagah, Shwebo Dist., Burma, Reg. No. [illegible].

83. **Trapezoideus pallegoixi** (Sowerby), Simpson, Syn. Naiades, Proc U. S. Nat Mus., XXII, p. 859, =*Anodon pallegoixi*, Sowerby, Conch. Icon., XVII, 1867, pl. xvii. fig. 17,=*Anodonta pallegoixi*. Clessin, Conch. Cab. Ano., 1876, p 210, pl. lxiv, fig. 6.

Siam, Reg. No. [illegible].

84. **Trapezoideus exolescens** (Gould), Simpson, Syn Naiades, Proc. U S. Nat. Mus., XXII, p 859, =*Unio exolescens*, Gould, Proc. Bost. Soc. Nat. Hist., 1844, p. 141; Hanley and Theobald, Conch. Ind., p. 43, pl. cvii. fig. 5,==*Margaron* (*Unio*) *exolescens*, Lea, Syn., 1852, p. 32; 1870, p. 51.

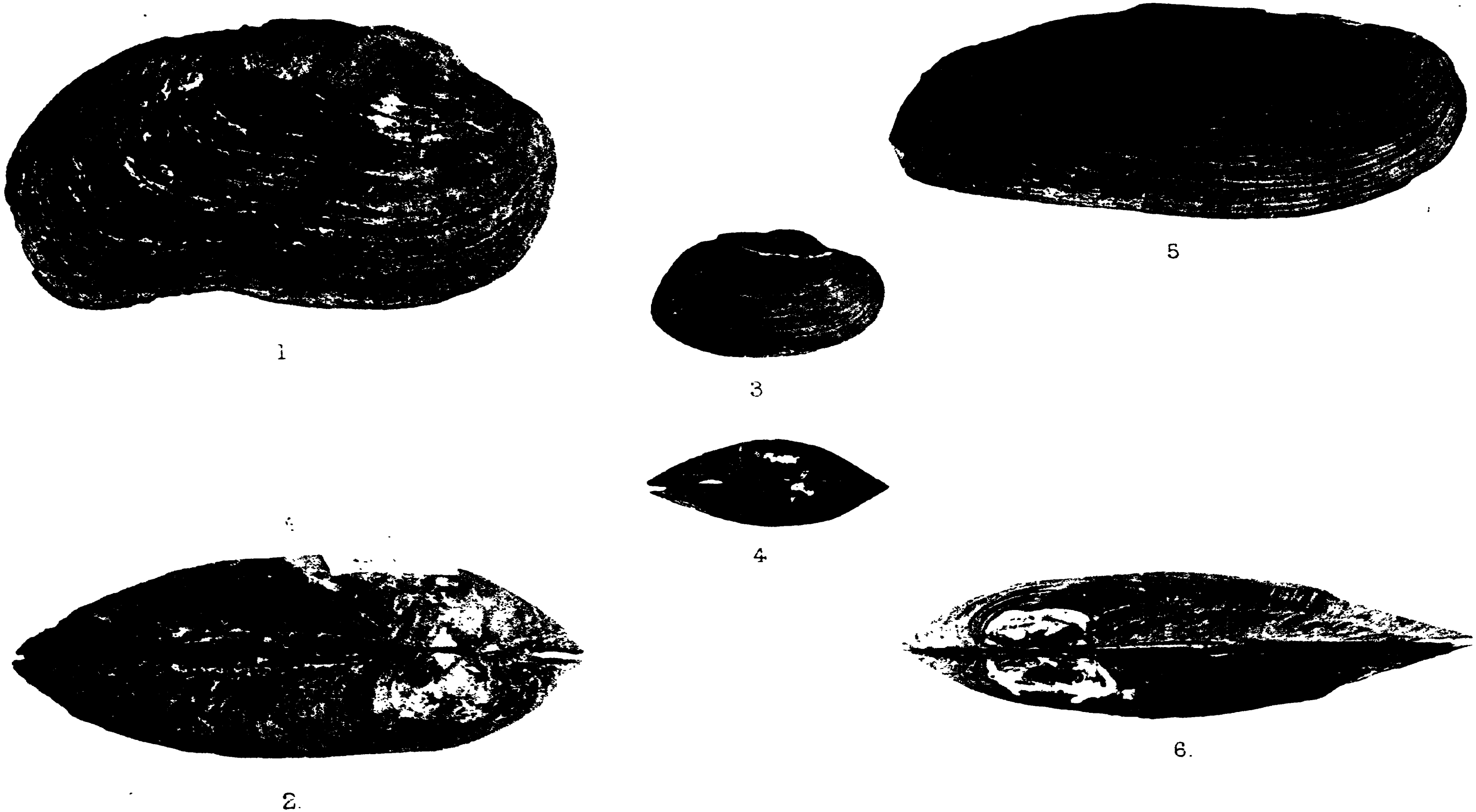
Bhamo, Reg. No. [illegible].

Genus **Arconaia**, Conrad 1865.

85. **Arconaia lanceolata** (Lea), Simpson, Syn Naiades Proc. U. S. Nat. Mus., XXII, p. 860, =*Triquetra lanceolata*, Lea, Proc. Ac. Nat. Sci., Philad., VIII, 1856, p 79, =*Hyria lanceolata*, Lea,

Proc. Ac. Nat. Sci., Philad., 1856, p. 300,=*Arconaia lanceolata*, Conrad, Am. Jl. Conch., I, 1865, p. 234,=*Triquetra contorta*, Lea. Proc. Ac. Nat. Sci., Philad., VIII, 1856, p. 300; Obs., VI, 1857, p. 39, pl. xxxiii, fig. 33,=*Hyria contorta*, Sowerby, Conch. Icon., XVII, 1869, pl. i, figs. *2a*, *2b*,=*Margaron* (*Triquetra*) *contorta*, Lea, Syn., 1870, p. 26,=*Unio contortus*, Heude, Conch. Fluv. Nank., 1877, pl. xv, fig. 31.

Lake Tungling, China, Reg. No. [illegible].



1, 2. Unio modiola. 3, 4. Nodularia (Nodularia) pecten. 5, 6. Unio perakensis.

MISCELLANEA.

GENERAL.

MALARIA MORTALITY IN THE FRINGE AREA OF CALCUTTA.—On p. 98 of Mr. C. A. Paiva's "Materials for a Survey of the Mosquitoes of Calcutta" (Rec. Ind. Mus, vii, 1912, pp. 93–98) it is stated that, as far as Calcutta is concerned, malaria is most common in the fringe area. Dr. Pearse, Calcutta Health Officer, writes informing us that, so far as can be judged from the death-rate per 1,000 from the disease, this had just ceased to be the case when the survey was instituted. He attributes the improvement largely to the drainage scheme commenced in 1909, and observes that "since 1908 the fringe area has compared very favourably with the eastern and southern wards of the city." Mr. Paiva tells me, moreover, that his record of adult malaria-carrying mosquitoes from this area is based on specimens collected prior to the initiation of the mosquito survey.

F. H. GRAVELY.

INSECTS.

ON THE LARVAL HABITS OF *Toxorhynchites immisericors*. In Mr. Brunetti's supplementary Catalogue of Oriental Culicidæ (Rec. Ind. Mus., vol. iv, No. x) I find a statement attributed to me with which I am not entirely in agreement.

On page 436, under *Toxorhynchites immisericors*, I am represented as asserting that "the larvæ prey first upon those of their own race before proceeding to devour those of other species," and again "Mr. E. E. Green thought it eats its own species first."

I was puzzled, for some time, to understand how or where I could have said anything to give rise to this impression, until on looking through my early paper on the life history of this insect ('Spolia Zeylanica,' vol. ii, pp. 159 to 164)—I found the following sentences:—"Confirmation of the supposed carnivorous habit was soon forthcoming: firstly, by the rapid disappearance of most of the young larvæ while the remainder waxed fat, and secondly, by the detection of one larva in the act of devouring a comrade the same size as itself." . . . . "Though well supplied

with *Culex* larvæ, the young *Toxorhynchites* continued to prey upon each other until but a single survivor remained in each vessel. Having a habit of backing blindly about in the water, they sooner or later come within reach of the jaws of their companions.''

As these remarks appear to be susceptible of an interpretation that was never intended by their author, I should like to take this opportunity of explaining them more fully.

With regard to the earlier paragraph, until their carnivorous proclivities had been definitely proved, the newly-hatched larvæ were crowded together in a single vessel, without those of any other species. They had therefore no choice but to devour each other—or starve.

In the second paragraph, I thought that the concluding sentence sufficiently explained the disappearance of the *Toxorhynchites* in spite of the presence of other *Culex* larvæ.

My experience was certainly not that of Mr. Paiva, who found "that the larva will devour that of any other species, if present, before attacking those of its own kind.''

I do not, for a moment, suppose that *Toxorhynchites* larvæ prefer to feed upon members of their own species; but I am equally doubtful of their preference for those of other species. I am inclined to believe that it is a matter of complete indifference to them and that the choice of prey is guided simply by opportunity. Their jaws instinctively close upon any wriggling creature that comes within reach—be it one of their own or an alien race. The more sluggish habit of the *Toxorhynchites* renders it a more easy prey, especially when combined with its habit of backing about on the surface of the water.

The fact remains that, in any restricted collection of water—such as the cup of a broken bamboo stem, it is seldom that more than a single fully-developed *Toxorhynchites* larva can be found, amongst a crowd of other Culicid larvæ.

E. ERNEST GREEN.

PERADENIYA, 15*th May*, 1912.

CRUSTACEA.

EAST ASIATIC SPECIES OF *Apus*.—When writing my notes on this subject (Rec. Ind. Mus., vi, 1911, p. 357) I was unable to give any references to *Apus granarius*, Simon. For the following I am indebted to Dr. W. T. Calman:—

Apus granarius, Simon, Ann. Soc. entom. France, ii, 1886, p. 446, and G. O. Sars, Ann. Mus. Zool. St. Petersburg, vi, 1901, p. 133, pl. i, pl. ii, figs. 1—12.

The species was first described from specimens found in the neighbourhood of Pekin, while the examples subsequently examined by Sars were obtained at several localities in Eastern Mongolia.

I have recently had opportunity of consulting Packard's full description of *Apus himalayanus* (Hayden's Ann. Rep. U. S. Geol. Survey for 1873, Washington, 1874, p. 327, pl. xvi, figs. 5, 5*a*), but I am still not convinced that the form is really distinct from *A. cancriformis*.

STANLEY KEMP.